CHAPTER 10

Osteological Indicators of Infectious Disease and Nutritional Inadequacy

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Introduction

The present chapter investigates the prevalence of infectious diseases and nutritional inadequacies in the New York African Burial Ground (NYABG) sample, as represented in bone. A broad range of skeletal indicators of pathology was assessed in the Cobb Laboratory. Diagnoses of specific diseases represented by skeletal indicators were usually attempted, as per the long-standing standards of paleopathologists. Data were also gathered in accord with the more strictly descriptive criteria of the new *Standards for_Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker 1994). Indeed, the pathology coding section of the *Standards* is clearly the most novel and complex feature of the guide, and we think it constitutes a significant forward step in paleopathologic methodology. Yet, as one of the first projects to utilize and test the *Standards* in their entirety, we found the strict pathology coding approach to be somewhat cumbersome and time consuming. To mitigate this problem, we developed pathology codes for computerization that saved time and effort without the loss of useful information. Therefore, the skeletal pathology and non-metric trait computer database developed at the New York African Burial Ground Project (NYABGP) is a simplified version of the pathology portion of the *Standards* (Buikstra and Ubelaker 1994:107-158).

The modifications of the African Burial Ground (ABG) pathology database simply improved efficiency for coding complex descriptions of the type, appearance, severity, and location of pathologies and interesting anatomical features for computerization and statistical manipulation. The information captured by these codes was consistent with the *Standards* as well as with the previous protocol of the Paleopathology Association and our own and other researchers' earlier approaches to data collection. For example, we established that severity descriptors such as "trace" (Kelley and Angel 1987) or "slight" (Blakey et al. 1994) are close to the standard's use of "barely discernable," as a descriptor, while observations of greater magnitude such as "moderate, severe, or extreme" easily fell within the "clearly present" category of the standards. Indeed, this simple two tier severity (or clarity) rating of the *Standards*, barely discernable compared to clearly present, accomplishes its goal of classifications that many specialists can agree on and that can be compared across many studies, including those conducted before the creation of the new standards. Since our project developed during this methodological transition, data were gathered deliberately to bridge the old and new methodologies. Pathology assessments were rendered as text that includes many diagnoses as well as descriptors that were converted into four-letter codes. In the future these bench-top diagnoses should be of interest while the descriptive coding will provide the nearly raw data from which alternative diagnoses may be made. In this chapter, we have relied principally on the use of our coded data.

This adapted coding system facilitated direct synthesis of pathology assessments, especially the ability to combine nominal, observed characteristics of an individual or group and combine these to create more complex diagnoses. This allowed us to produce clinically meaningful categories of pathology from the wealth of descriptors in our database (16,635 observations of pathology). Care was taken to retain the level of specificity, clear terminology, and emphasis on description (rather than specific pathological diagnoses) that was emphasized by the *Standards* (Buikstra and Ubelaker 1994:107-108).

It should be noted that some distinctions such as those made between active and healed, "reactive woven bone" and "sclerotic," lesions require considerable subjective evaluation (Figures 10.1, 10.2, 10.3, and 10.4). As with other qualitative descriptions, we feel that the large numbers of observations made in this study substantially reduce the effects of errors due to possible misidentification/miscoding of marginal cases. The statistical associations found between plausibly associated variables are supportive of a swamping effect on any marginal errors.

Three hundred and six of a total of 419 individuals in the NYABG exhibit at least one identifiable pathology or non-metric skeletal trait. A further 52 individuals were assessed though no abnormalities were observed. It must be noted, however, that this number includes individuals who were very poorly preserved but whose "observable" skeletal elements or fragments did not present evidence of abnormalities.[1] Sixty-one of 419 individuals were not assessed for pathologies or non-metric skeletal traits; the majority (n = 55) were too poorly preserved to be evaluated.[2] Of these 61, five individuals were quarantined due to potentially harmful fungi found in pedestal soil and therefore could not be assessed. Burial #100, a young subadult in poor condition who remained in an earthen pedestal intermingled with its badly decayed coffin, was also not assessed.

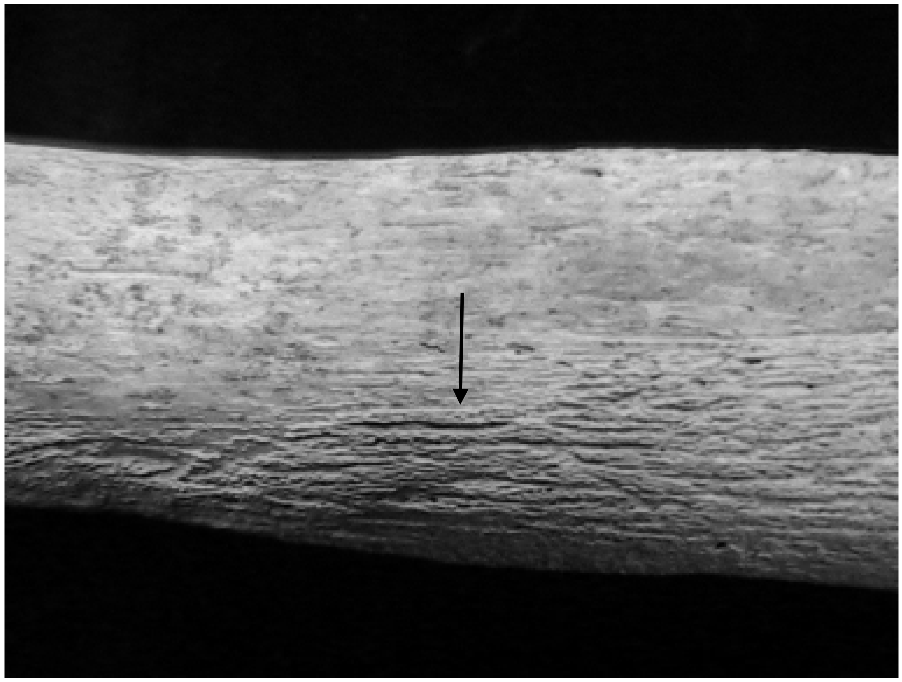

Figure 10.1: Active periostitis on left posterior ulna of a 35-45 year old male (Burial 70)

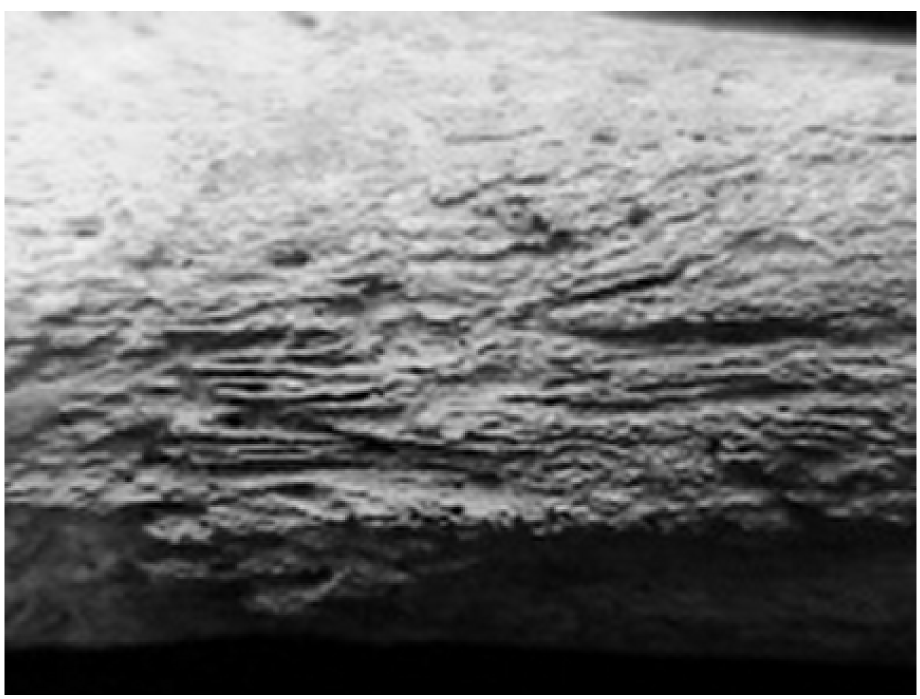

Figure 10.2: Active periostitis on left posterior ulna of a 35-45 year old male, magnified (Burial 70)

Figure 10.3: Healed, sclerotic periostitis on right lateral tibia of an adult male (Burial 69)

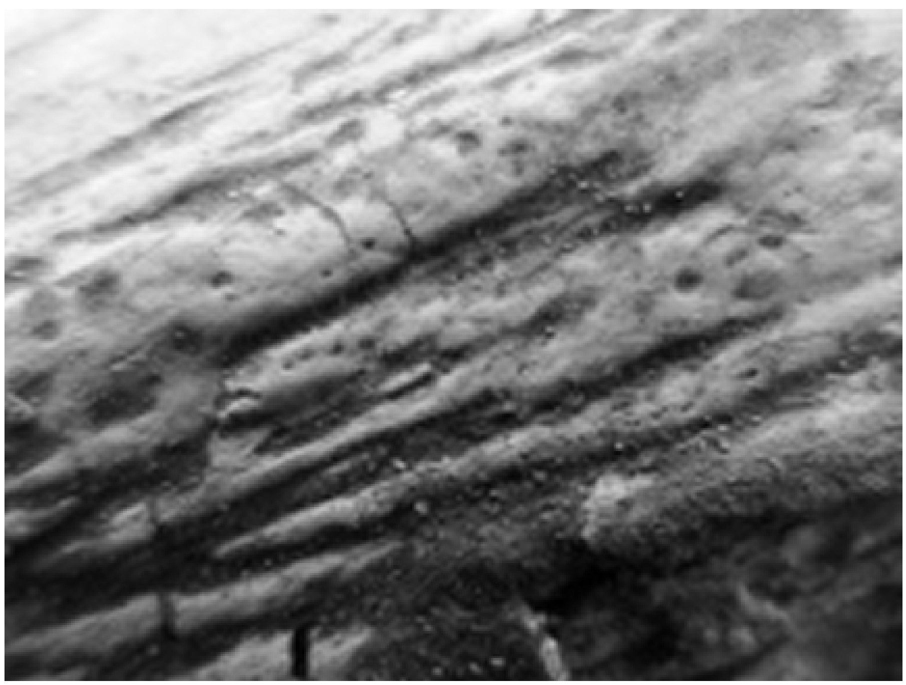

Figure 10.4: Healed, sclerotic periostitis on left lateral tibia of a 45-50 year old male, magnified (Burial 20)

Therefore, for purposes of this study a total sample size of 358 individuals will be utilized in analyzed (Table 10.1). This sample includes 105 subadults younger than 15 years old, 237 adults 15 years old or older (115 males, 85 females), and 16 individuals for whom age and sex were undeterminable.[3] While these sample sizes will be used in general statements regarding disease prevalence, in cases where a more restricted sample size was warranted (e.g., numbers of investigated crania for porotic hyperostosis), sample sizes were generated with the aid of the skeletal inventory database.

The central focus of this chapter is the prevalence of general and specific infectious disease and nutritional inadequacy indicators observed in the NYABG skeletal sample. General infectious periostitis is considered first. We report prevalence of cases, healed versus active lesions, age and sex distributions of those affected. These data are followed by comparative analysis with data from the First African Baptist Church (FABC), a nineteenth-century free urban sample (Rankin-Hill 1997); 38CH778, a southern plantation population, 1840 - 1870 (Rathbun 1987); and Cedar Grove, a post-reconstruction rural population (Rose and Santeford 1985) (Table 10.2). Following discussion of general infectious disease, the occurrence of specific disease indicators, especially treponemal disease, will be considered. We then combine the NYABG skeletal data with historical information and thus discuss the potential type, and/or types, of treponemal infection present in this sample. These findings will be compared to the high rates of syphilis found at the Waterloo Plantation population from Suriname (Khudabux 1991).

Table 10.1: Age Structure of Assessed Sample

Age	Sex			Total
	Male	Female	Unknown	
.00 - .49			23	**23**
.50 - .99			14	**14**
1.0 - 1.9			12	**12**
2.0 - 2.9			3	**3**
3.0 - 3.9			6	**6**
4.0 - 4.9			10	**10**
5.0 - 5.9			3	**3**
6.0 - 6.9			2	**2**
7.0 - 7.9			5	**5**
8.0 - 8.9			3	**3**
9.0 - 9.9			5	**5**
10.0 - 10.9			3	**3**
11.0 - 11.9			0	**0**
12.0 - 12.9			4	**4**
13.0 - 13.9			3	**3**
14.0 - 14.9			2	**2**
"Subadult"			7	**7**
15.0 - 19.9	7	8	4	**19**
20.0 - 24.9	10	5	1	**16**
25.0 - 29.9	7	4	2	**13**
30.0 - 34.9	10	16	2	**28**
35.0 - 39.9	12	9	0	**21**
40.0 - 44.9	18	5	0	**23**
45.0 – 49.9	17	8	2	**27**
50.0 – 54.9	15	5	1	**21**
55+	6	8	0	**14**
"Adult"	13	16	25	**54**
"Undetermined"	0	1	16	**17**
Total	**115**	**85**	**158**	**358**

Table 10.2: African Diaspora Skeletal Series Discussed in this Chapter
(Adapted from Rankin-Hill 1991)

Site/Location	Time Periods	Total Number of Burials	Life Style	Reference
Newton, Barbados	1660 - 1820	104	plantation enslaved	Jacobi et al., 1992
New York African Burial Ground	1697 - 1794	419 (358 assessed for pathology)	urban enslaved	
St. Peter's Cemetery, New Orleans	1720 - 1810	31	urban enslaved	Owsley et al., 1987
Catoctin Furnace, Maryland	1790 - 1820	31	industrial enslaved	Kelley and Angel 1987
Waterloo Plantation, Suriname	1793/1796 – 1861	25	plantation enslaved	Khudabux 1991
FABC – 8th and Vine, Philadelphia	1821 - 1843	144	ex-slaves/ freeborn	Rankin-Hill 1997
38CH778, South Carolina	1840 - 1870	36	plantation enslaved	Rathbun 1987
Cedar Grove Cemetery, Arkansas	1890 - 1927	78	rural farmers	Rose and Santeford 1985

The potential for metabolic disruption resulting from nutritional inadequacy, as exhibited by the presence of porotic hyperostosis, will be addressed in the second section. The rates of porotic hyperostosis exhibited in the individuals of the ABG will once again be compared primarily to those encountered within the Cedar Grove, 38CH778, and FABC samples. The possible presence of rickets or vitamin-D deficiency will be considered based on the presence of bilateral medial/lateral bowing of long bones of the lower limbs. The third and final section will assess the interaction of infection and nutritional inadequacy by investigating the co-occurrence of porotic hyperostosis and periostitis. Information from the NYABG will be compared with available data from Cedar Grove and FABC.

Overall, this chapter relates the NYABG paleopathology and the New York historical documentation. Therefore, the chapter tests the historical conclusions (History Report, Chapter 10) concerning the exposure of enslaved Africans to infectious pathogens in New York and prior to their involuntary transport to the New World.

Infectious Disease

Assessment of skeletal pathology observed in the individuals from the NYABG yielded numerous cases of boney response to infectious agents. The most common of these lesions were associated with abnormal bone found on the outer, periosteal surface of skeletal elements. This abnormality, commonly termed periostitis or periostosis,[4] can be the result of specific disease (e.g. direct bone infection or trauma) or as part of a broader expression of infectious disease (e.g. treponemal infection) (Ortner 2003:207-208). With the possible exception of traumatic periostitis,[5] the case can be made that most periostitis is associated with an infectious agent. For the purposes of this chapter, the presence of periostisis will be initially discussed as a general indicator of infectious disease. In the subsequent discussion of treponemal disease, periostisis will be considered a specific expression of this disease.

Over half, 200 or 55.9 percent, of the individuals in the ABG were affected by generalized infectious disease or periostitis (Tables 10.3 and Table 10.4). All but 15 of these individuals, 92.5 percent, exhibited more than one infectious locus, including 44 subadults and 153 adults, or 41.9 percent and 64.6 percent of these age groups. Among subadults, femora were the most common element affected, followed by the humeri and tibiae. In contrast, among adults, the tibiae were the most commonly impacted, followed by the femora and fibulae.

Regarding severity, among those that exhibited periostitis, 74 (37.0 percent) individuals had at least one lesion that was assessed as "clearly present" (as opposed to "barely discernable" or no severity determined). Among subadults, three of the 44 (6.8 percent) exhibited at least one periostitic lesion that was assessed as clearly present. Adults displayed a significantly[6] higher proportion of individuals with clearly present lesions, 68 or 44.4 percent of those with periostitis. Periostitis prevalence varied little between males and females – 81 or 70.4 percent in males and 60 or 70.6 percent in females. However, males do have a statistically significantly higher incidence of individuals with lesions classified as clearly present. Forty-four, or 54.3 percent of the males with periostitis, showed clearly present lesions, compared to 21 or 35.0 percent of the females.

Of the 200 individuals with periostitis in the ABG, 126 or 63.0 percent exhibited only healed lesions, 18 or 9.0 percent displayed only active lesions, and 34 or 17.0 percent had a combination of both active and healed lesions. Among adults the distribution of lesion status was: 113 or 73.9 percent healed periostitis, 2 or 1.3 percent active lesions, 30 or 19.6 percent both active and healed lesions. Differentiated by sex, adult males and females displayed only slight differences (not statistically significant) in the status of periosteal lesions: healed - 62 or 76.5 percent for males, 42 or 70.0 percent for females; active - 1 or 1.2 percent in males, 0 in females; and both active and healed - 16 or 19.8 percent for males, 13 or 21.7 percent for females. In subadults, of those who had periostitis, 10 or 22.7 percent exhibited healed lesions, 16 or 36.4 percent displayed active lesions, and 4 or 9.1 percent had a combination of both healed and active lesions. Not surprisingly, those under one year of age expressed only active periostitis, having died before observable healing could have occurred. Compared to adults ($p<.001$), children were prone to dying during their first active infection that was sufficiently severe to leave boney evidence. The dental developmental defects discussed in Chapter 12 suggest that the majority of older children had experienced bouts of

Table 10.3: Occurrence and Status of Generalized Infectious Disease

	n†	Total %	Clearly Present %	Active % ‡	Healed % ‡	Both % ‡
Subadult	105	**41.9**	6.8	36.4	22.7	9.1
Adult	237	**64.6**	44.4	1.3	73.9	19.6
Female	85	**70.6**	35.0	0.0	70.0	21.7
Male	115	**70.4**	54.3	1.2	76.5	19.8
Total	**358**	**55.9**	**37.0**	**9.0**	**63.0**	**17.0**

† "n" equals the number of individuals assessed for pathology.
‡ Status values represent the percentage in each group of those with evidence of generalized infectious disease; "missing" percentages represent those whose lesions were unassessed/unassessable for status.

Table 10.4: Generalized Infectious Disease Statistical Testing: Intra-Population

	Generalized Infectious Disease Presence/Absence		Clearly Present Presence/Absence		Status of Lesions	
	x^2	P	x^2	P	x^2	p
Subadult/Adult	15.288	<.001	20.988	<.001	73.473	<.001
Male/Female	.001	.981	5.178	.023	.084†	.772

† Conditions for 2X3 contingency table not met, x^2 reflects the collapsing of "Active" and "Both" categories.

disease and nutritional stress earlier in their lives that left evidence in the disrupted development of teeth, if not in the bone. As subsequent discussion explores, these pathology indicators in bone represent the 'tip of an iceberg' of disease and ill health that for various reasons will often leave the skeleton unaffected.

When compared with periostitis rates for the FABC (Rankin-Hill 1997), 38CH778 (Rathbun 1987), and Cedar Grove (Rose and Santeford 1985), the NYABG sample exhibits similar, slightly lower infection frequencies (Figure 10.5, Table 10.5).[7] However, differences in rates found between 38CH778 and the ABG were not found to be statistically significant. When differentiated by age category, it was found that the NYABG subadult infection frequency was intermediate between the high rates reported in Cedar Grove and 38CH778 – though not statistically significant – and the lower rate observed in FABC. Among adults, rates of infection at the ABG are similar to the high prevalence found at Cedar Grove and in 38CH778. Females in the Cedar Grove and the ABG samples have nearly identical periostitis prevalence figures (approximately 71 percent).

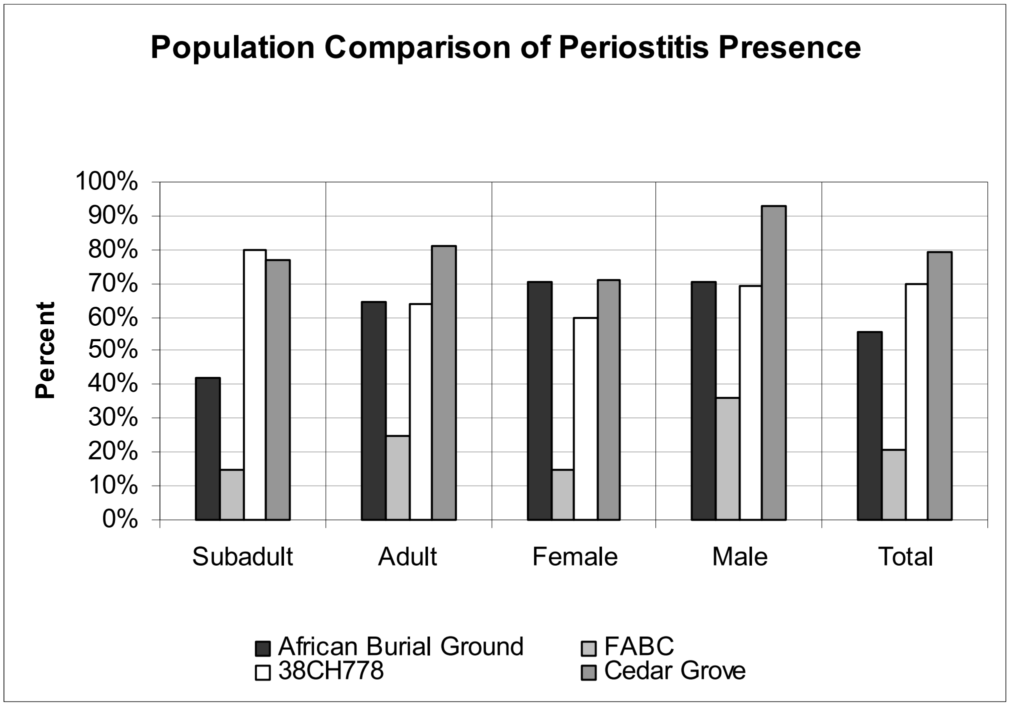

Figure 10.5: Population Comparison of Periostitis Presence

Table 10.5: Generalized Infectious Disease Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove		African Burial Ground/38CH778	
	x^2	p	x^2	p	x^2	p	x^2	p
Subadult	43.722	<.001	12.676	<.001	15.549	<.001	1.480†	.224
Adult	48.116	<.001	35.443	<.001	3.600	.058	.033†	.857
Female	38.788	<.001	32.724	<.001	.037†	.848	.265†	.607
Male	22.856	<.001	13.746	<.001	2.468†	.116	.053†	.818
Total	>50	<.001	48.654	<.001	14.273	<.001	2.359	.125

† Yeats Correction for Continuity utilized due to small "expected" cell values.

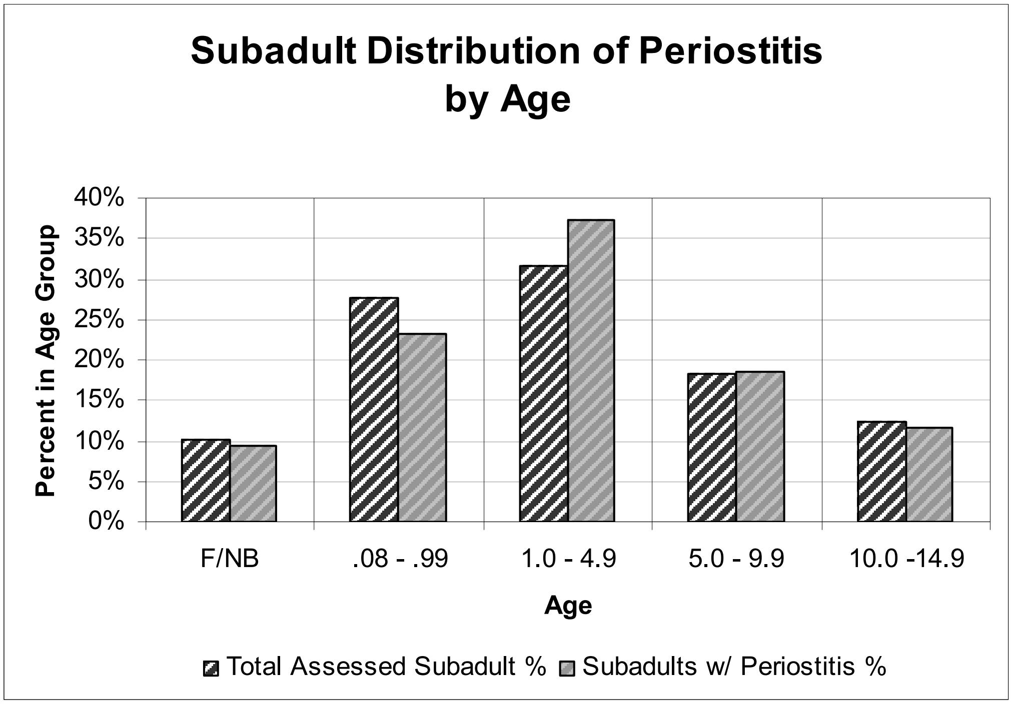

Figure 10.6: Subadult Distribution of Periostitis by Age

While not statistically significant, incidence figures for males from Cedar Grove (93 percent) exhibit a 22 percent higher incidence of periostitis than males from the ABG (70.4 percent). The periostitis rate among males from the ABG is most comparable to the rates observed in the 38CH778 South Carolina plantation population (69 percent).

The distribution of subadults from the ABG sample displaying generalized infection closely mirrors the overall age structure for this subgroup (Figure 10.6). The disparity observed in the two age distributions may reflect older individuals that survived previous episodes with infectious disease versus younger individuals who may have perished before skeletal involvement occurred. Interestingly, all individuals (9) younger than one year exhibited only active lesions. It is in the older 1.0 – 4.9 age group in which the first cases of healed lesions are encountered (2 with only active lesions, 5 with only healed lesions, 2 with a combination of healed and active lesions). Comparing individuals with periostitis in different age groups, an increase in prevalence encountered after the first year (Figure 10.7) may reflect individuals who survived earlier insults. The rate of infection appears to decrease once again in subadults after five years of age. Indeed, our mortality data show a decline and stabilization in age-specific deaths among older children. Having weathered the vulnerable circumstances of infancy and weaning, older children usually will not see a major wave of new stresses until adolescence and young adulthood.

Subadult periostitis rates for the NYABG sample fall between those from Cedar Grove and FABC in most age categories (Figure 10.8). The proportions of periostitis in the ABG are consistently higher than those found in FABC, and considerably lower than Cedar Grove. However, in the oldest age group the trend

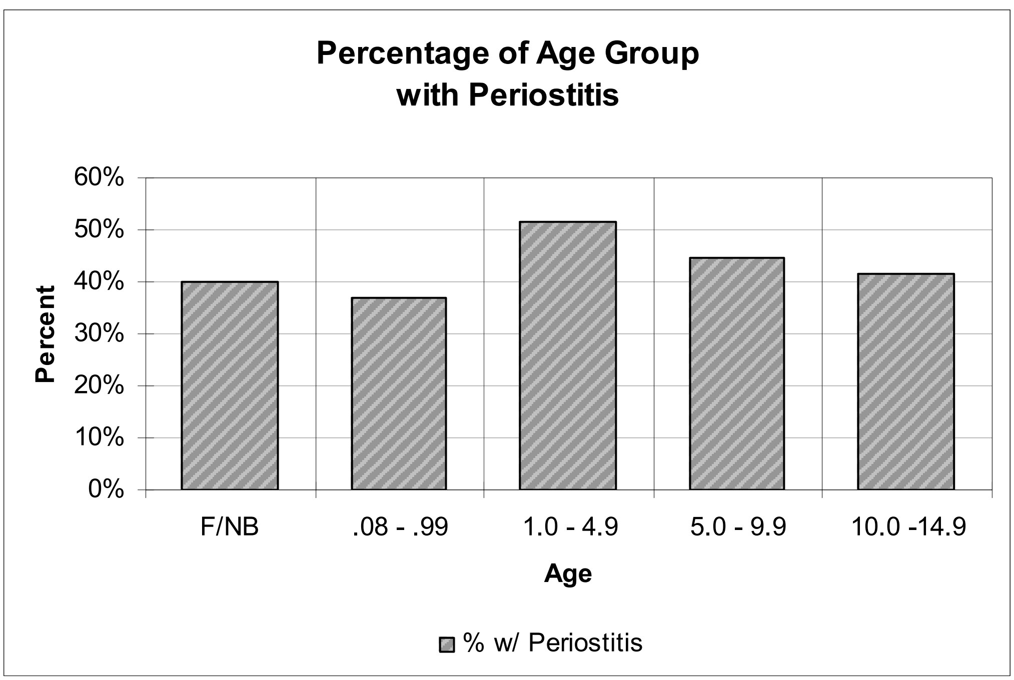

Figure 10.7: Percentage of Age Group with Periostitis

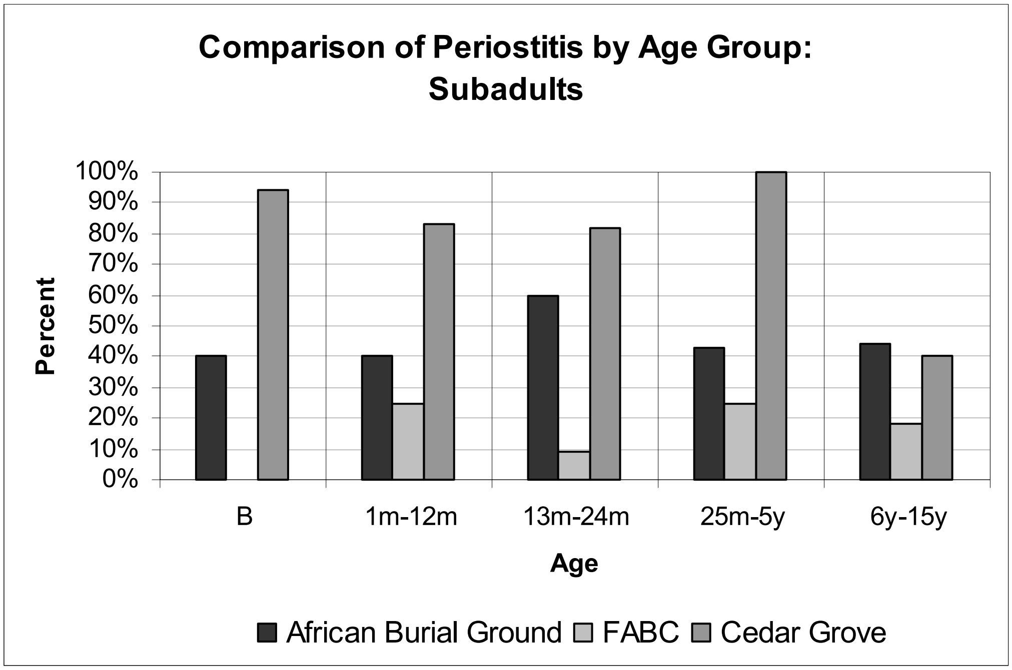

Figure 10.8: Comparison of Periostitis by Age Group: Subadults

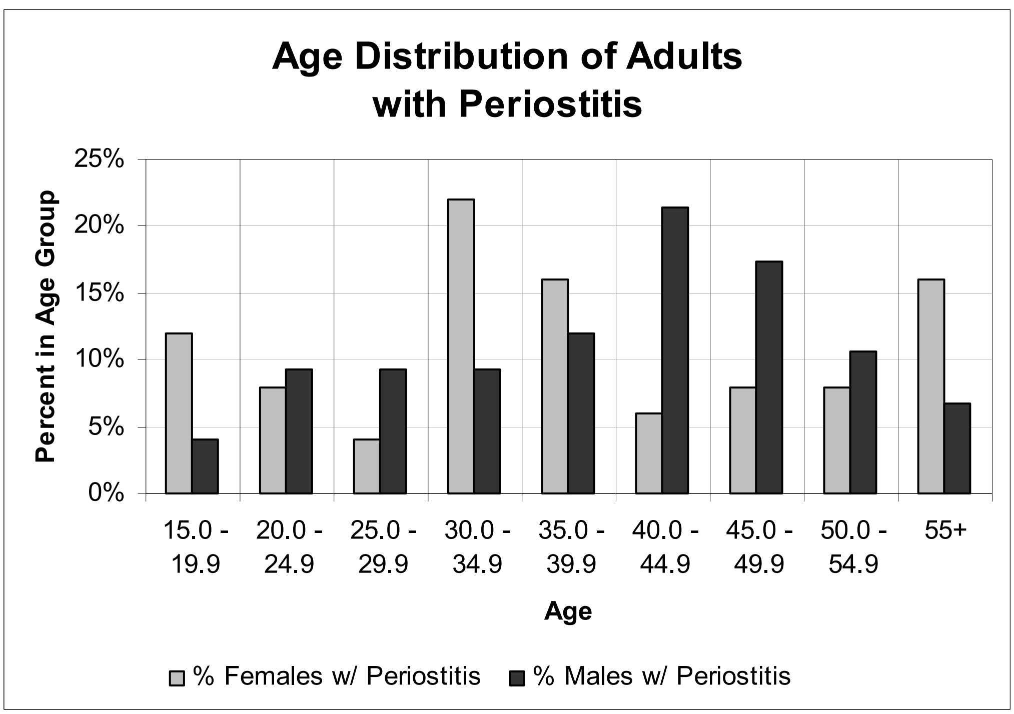

Figure 10.9: Age Distribution of Adults with Periostitis

changes slightly, with the ABG 6 to 15 year olds having a 4 percent higher rate (44.4 percent) of periostitis than individuals in the same age group from Cedar Grove (40 percent).

Males and females in the ABG sample present generalized infection patterning (Figure 10.9) that mirrors their sex-specific mortality profiles. The occurrence of periostitis is greater than 50 percent in most male and female age groups throughout the adult segment of the population (Figure 10.10). Interestingly, both males and females seem to exhibit a bi-modal distribution of affected individuals: males with peaks in 25.0 – 29.9 and 44.0 – 44.9 age groups, females with peaks in 20.0 – 24.9 and 35.0 – 39.9 age groups. Both males and females display another peak at 55+, though this would not be unexpected given that this age group represents the potential accumulation of a lifetime of skeletal indicators of generalized infection.

When comparing these adult proportions to those of FABC and Cedar Grove, it is observed that, like the subadult pattern, the New York adults exhibited frequencies of infectious disease indicators that are intermediate of these two examples (Figures 10.11 and 10.12). Once again the rates of periostitis among the adults at the ABG are higher than FABC, however, not as extreme as the rates found in Cedar Grove population for most age groups.[8] Only in the female 30.0 – 39.9 age range did the rate of periostitis in the ABG (76.0 percent) exceed the extraordinary rates reported for Cedar Grove (55 percent).

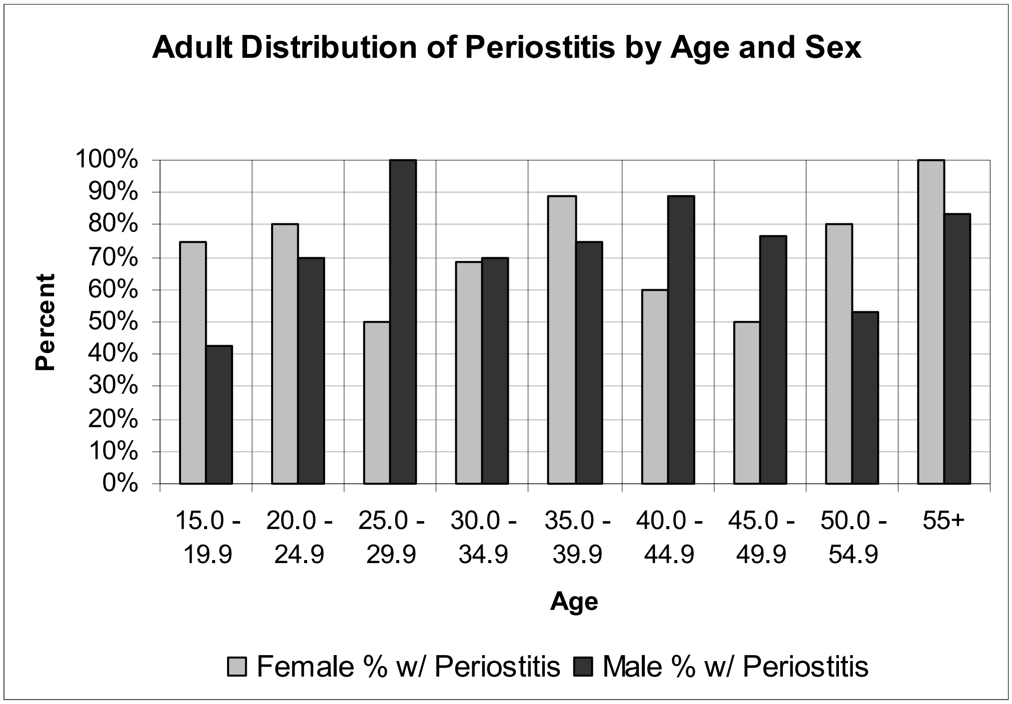

Figure 10.10: Adult Distribution of Periostitis by Age and Sex

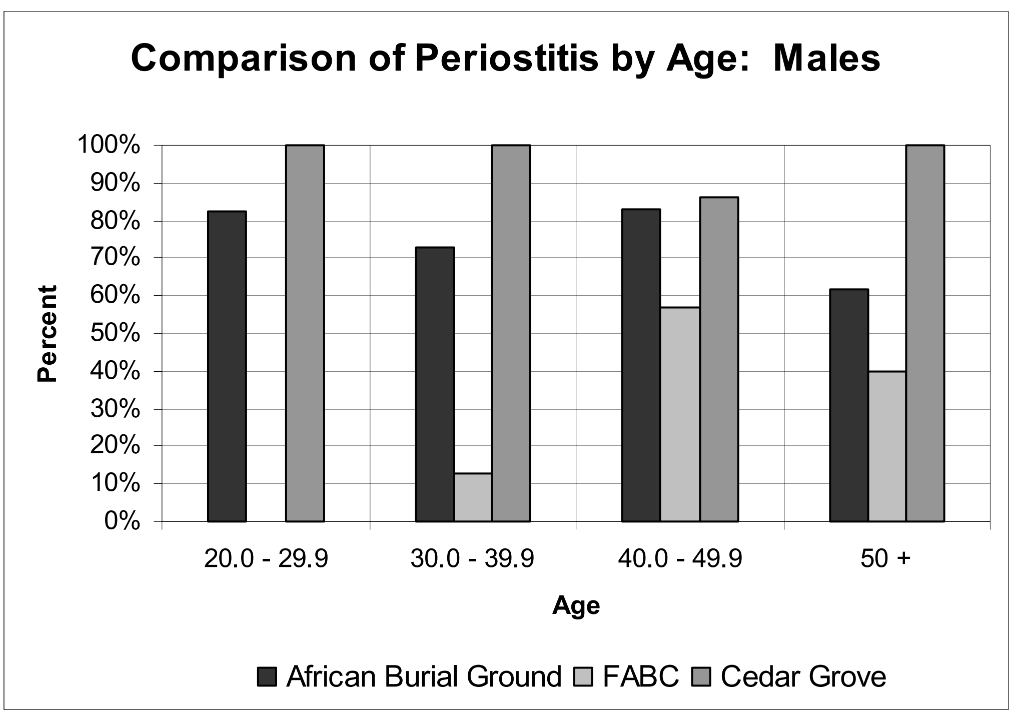

Figure 10.11: Comparison of Periostitis by Age: Males

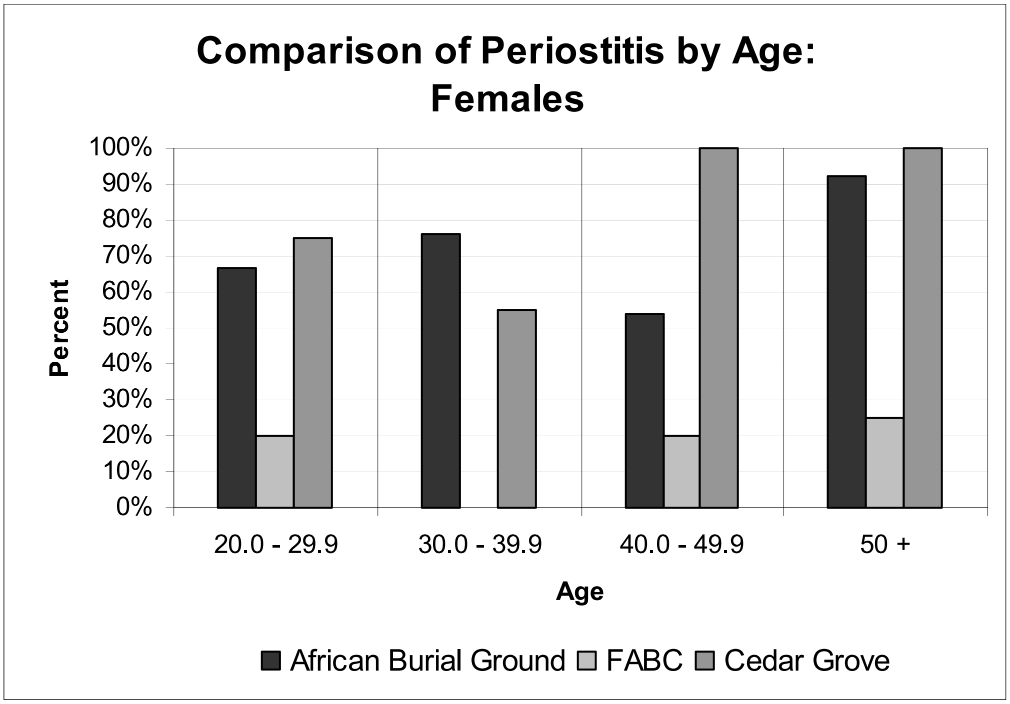

Figure 10.12: Comparison of Periostitis by Age: Females

Other infectious processes observed in the NYABG series include meningeal reactions. Meningeal reactions, as utilized in this study, refer to both hemorrhagic and inflammatory meningeal reactions (Schultz, 2003:93-94). We would like to underscore at this time no diagnoses of specific meningeal diseases have been made. The generalized diagnosis of meningeal reaction was made in seven individuals: 6 were subadults younger than 6 years old and one 25 - 35 year old female. The occipital most commonly affected, though lesions were also found on the parietals and the frontal.

Osteomyelitis, abnormal bone formation possibly associated with bacterial infection, (Ortner 2003:181) was also observed within the NYABG series. This infectious process was identified in five adults: two females (17 - 21 and 50 – 70 years old), two males (40 - 50 and 50 – 60 years old), and one individual of indeterminate sex and age. At least two elements were affected in all five individuals; however, no clear patterning of lesion locations suggestive of a specific pathogen was evident in these individuals. The most severe case was found in Burial 32, a male 50 – 60 years old, who displayed systemic osteomyelitis (Figures 10.13 and 10.14).

A third example of specific infection is a constellation of pathologies that may reflect treponemal infection (Figure 10.15), including “saber shin,” a feature associated with congenital syphilis and bejel (Ortner and Putschar 1981:210; Ortner 2003:278,294; Steinbock 1976:102) or “boomerang leg” yaws (Ortner and Putschar 1981:180; Ortner 2003:275; Steinbock 1976:145).[9] We observed no obvious evidence of "stellate scars" ("caries sicca"), frequently associated with the gummatous cranial lesions of venereal syphilis (Steinbock 1976:129) or yaws (Ortner 2003:276) in the NYABG sample. In total, eleven individuals (4 percent of those with observable tibiae) presented evidence saber shin (Table 10.6). All but one of these were adult males; eight between the ages of 30.0 and 54.9 and two of unknown adult age. The remaining individual was a skeleton of unknown sex and undeterminable age.

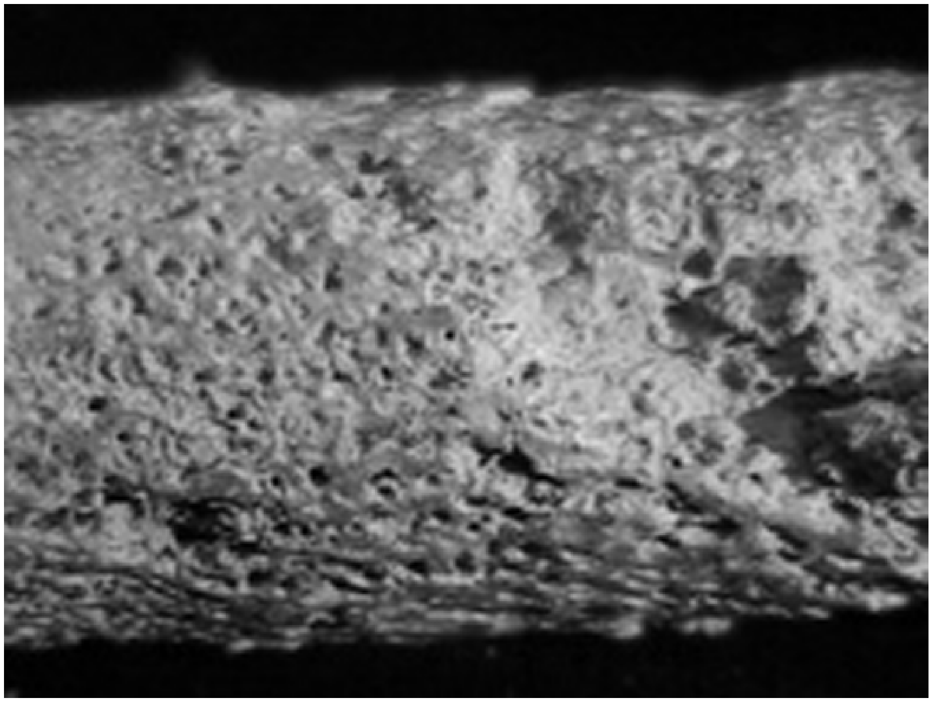

Figure 10.13: Osteomyelitis in the right anterior distal femur (Burial 32, 50-60 year old male)

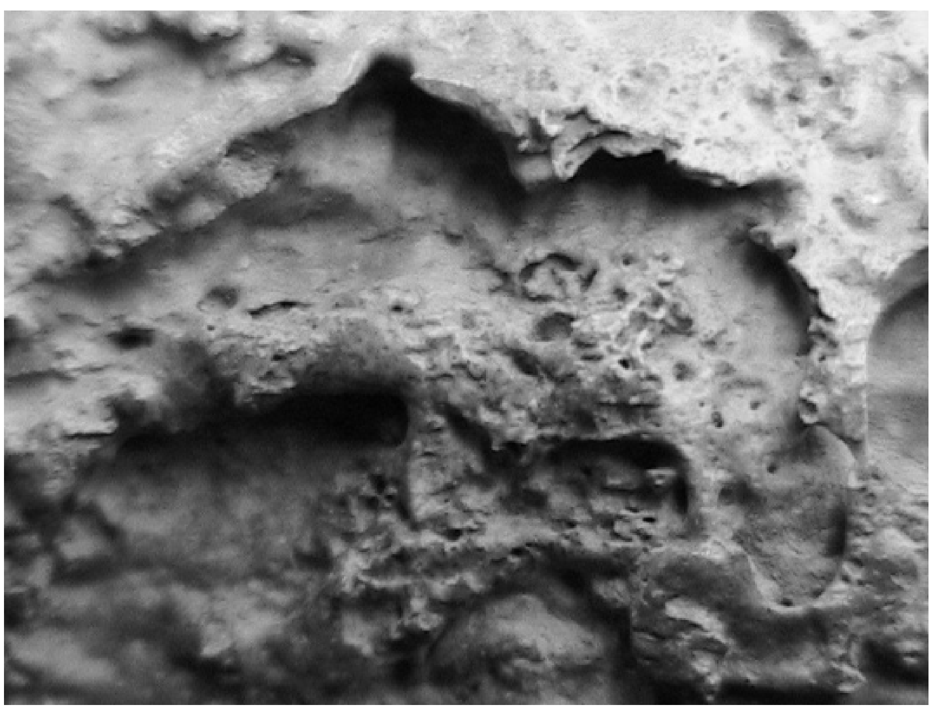

Figure 10.14: Osteomyelitis in the right anterior distal femur, magnified (Burial 32, 50-60 year old male)

Figure 10.15: Left femoral midshaft of Burial 101 (26-35 year old male, top) showing 'saber shin' bowing in comparison to a healthy femur from the Cobb collection (CC2, bottom)

Table 10.6: Occurrence of Treponemal Infection Indicators

	n[†]	Saber Shin		Suite of Tibial Pathologies		Total	
		n[‡]	%	n[*]	%	n[**]	%
Adult	181	10	5.5	28	15.5	**38**	**21.0**
Female	69	0	0.0	7	10.1	**7**	**10.1**
Male	89	10	11.2	18	20.2	**28**	**31.5**
Total Series	**249**	**11**	**4.4**	**29**	**11.6**	**40**	**16.1**

[†] "n" equals the number of individuals with observable tibiae
[‡] "n" equals the number of individuals diagnosed with saber shin
[*] "n" equals the number of individuals exhibiting a suite of tibial pathologies indicative of treponemal infection
[**] "n" equals the total number of individuals observed with these pathologies

From this baseline information, a database script was created to search for additional individuals that were not initially diagnosed with “saber shin” explicitly but whose skeletal changes were consistent with this diagnosis. The suite of descriptors we sought included: periostitis, anterior bowing, medial/lateral flattening (platycnemia), and/or fusiform expansion of the diaphysis/anterior crest. This combination of indicators (with the possible exception of the fusiform diaphysis) is definitive of “saber shin” and may be taken as an exhaustive sample of possible cases. This search yielded an additional 29 individuals that could possibly have treponemal infection, increasing the total to 40 or 16.1 percent of individuals with assessable tibiae. None of these individuals appears to be under the age of 15; however, two are of unknown sex and undeterminable age. This would correspond to 21.0 percent of the being affected. This number includes 7 females (10.1 percent) and 28 males (31.5 percent). Statistical testing found this difference to be significant (χ^2 =10.241, p=.001). The age profile for these individuals exhibits the highest frequencies of those affected between 30.0 and 54.9 years (males), and 30.0 – 34.9 years (females) (Table 10.7). These frequencies mirror the mortality curve of the population and may reflect age-specific risk.

These 40 individuals were then assessed for the presence of lytic and blastic lesions to evaluate lesion patterning and to assist in differential diagnosis between various treponemal infections. The tibiae were by far the most commonly affected element, followed by the femora and fibulae, sequentially. Overall, in most individuals (n = 30, or 75.0 percent) the lesions appeared healed, one person (2.5 percent) exhibited only active infection, and 9 individuals (22.5 percent) had a combination of active and healed lesions. Possible evidence of involvement in the facial area, which may be expressed in yaws, venereal syphilis or congenital syphilis (Ortner 2003:277, 283, 293), was detected in seven individuals (17.5 percent). However, as noted previously, no stellate scars were detected on their cranial vaults.

Table 10.7: Demographic Profile of Occurrence of Treponemal Infection Indicators

	Male	Female	Unknown	Total
15.0 - 19.9	1	1	1	3
20.0 – 24.9	1	0	0	1
25.0 – 29.9	1	0	0	1
30.0 – 34.9	4	4	0	8
35.0 – 39.9	3	0	0	3
40.0 – 44.9	3	1	0	4
44.0 – 49.9	5	0	1	6
50.0 – 54.9	4	0	0	4
55 +	1	1	0	2
"Adult"	5	0	1	6
Total Series	**28**	**7**	**3**	**38**

While the identification of specific treponemal diseases cannot be made with any certainty, some inferences can be made, based on 1) the region where these individuals were living both prior to and during their enslavement in New York, 2) lesion patterning, and 3) historic documents. The location of New York, as well as the African locations from which these people originated, seems to effectively rule out the presence of endemic syphilis (bejel) and pinta. Endemic syphilis, while found in Africa, is typically located in arid climates in the Old World (Ortner and Putschar 1981:180; Steinbock 1976:138).

Pinta, which only impacts the skin of the affected individual, is found in tropical areas of the New World (Ortner and Putschar 1981:180; Steinbock 1976:91). This would limit possible sources of treponemal infection to yaws, venereal syphilis, and congenital syphilis.[10]

The apparent absence of stellate scars, often associated with venereal syphilis, would seem to argue against the presence of this form of treponemal infection (Ortner and Putschar 1981:188-190; Steinbock 1976:129). This paucity of classic evidence of venereal syphilis is especially telling, given the large size of the observable sample. One individual, Burial 230 (55 - 65 year old female), exhibited a cranial lesion similar to a stellate scar; however, the lesion lacked some of the diagnostic characteristics of such lesions (Figure 10.16). Another individual, Burial 418 (30 - 55 year old male), exhibited lytic lesions that could be interpreted as cloacae associated with venereal syphilis (Figure 10.17). Furthermore, while most if not all individuals discussed here are of sexually mature age, the presence of the saber shin anomaly would seem to suggest involvement during their earlier growth and development.

Thus, the occurrence of the saber shin anomaly would suggest either congenital syphilis or yaws (Ortner and Putschar 1981:180,210; Ortner 2003:275,294; Steinbock 1976:102,145). Furthermore, if congenital syphilis and yaws are considered the primary possibilities, it can be argued that onset occurred prior to arrival in New York. The historic documentation for this period suggests that venereal syphilis was rare in the regions of Africa where persons were being enslaved for transportation to the Americas (History Component Report, Chapter 10). This reality, in conjunction with the fact that most women were brought directly from Africa to New York, may reduce the frequency of venereal syphilis in this segment of the population. The high proportion of females to males in New York, a marked contrast to the Caribbean, would also reduce the accelerated contagion found in the Caribbean where a small proportion of females, often sexually exploited by slave holders while sexually active with African men, could rapidly spread venereal disease to African compatriots (see Chapter 7 for discussion of sex ratios). However, New York males were often being brought from the Caribbean where venereal syphilis was known to have spread to substantial numbers of enslaved Africans.

These two trends together may help explain the disparity of treponemal infection that is seen in the sex distribution in the population of the ABG. If the dearth of lesions indicative of sexually acquired syphilis suggests a limited number of individuals in the population with this disease, then infection by congenital syphilis (from mothers at or before birth) may be coming from an affected external population. Fundamentally, congenital syphilis in a community requires venereal transmission of the disease in the community where its members were born in order for it to persist. This possibility would point mainly toward adults who were born in the Caribbean. Furthermore, if there was substantial venereal syphilis in colonial New York, the rates of the congenital disease among African adults would have been much attenuated by the very high mortality of infants that constituted a barrier to the proliferation of congenital disease.

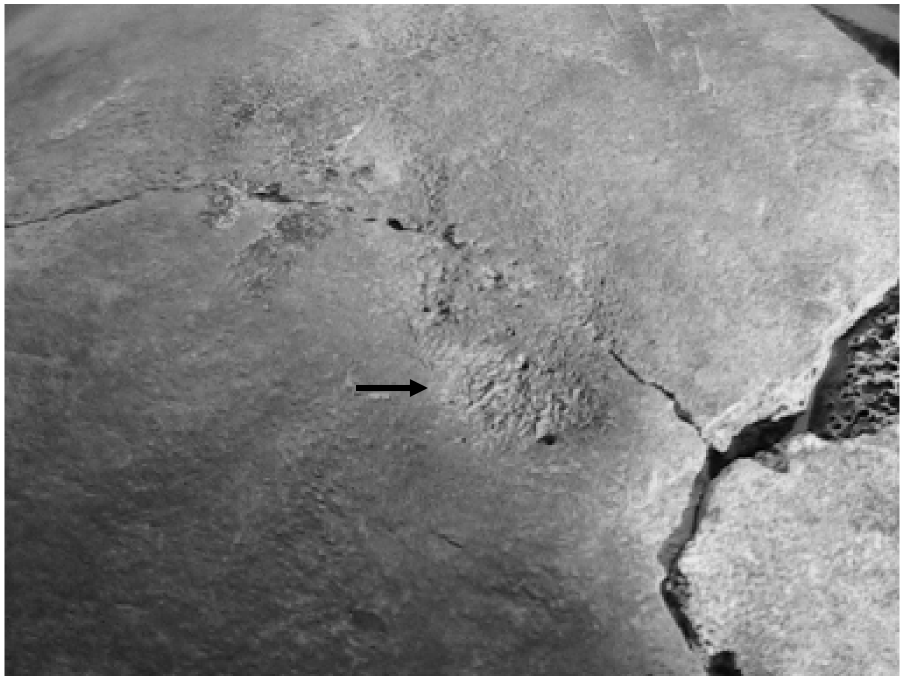

Figure 10.16: The cranial lesion (arrow) in the left parietal of a 55-65 year old female (Burial 230) is more similar to stellate scars than any other lesion observed in the African Burial Ground population, yet it lacks the billowing of its margins and other typical characteristics of such scars (Most probably a depression fracture).

Figure 10.17: Cobb Collection (CC101) Left femur showing cloaca in a person who died while diagnosed with syphilis in 1937 (left). An adult male 30-55 years of age in the African Burial Ground population (Burial 418) was found to have similar resorptive lesions in the right posterior proximal ulna (center) and left posterior proximal femur (right). Such diagnostic evidence of syphilis was otherwise not observed among the skeletal remains of New York Africans.

On the other hand, this pattern of treponemal indicators may also point directly to yaws among African-born individuals. Yet, the temperate climatic zone of New York would not have been conducive to the transmission of this tropical disease. The fact that captives are being imported continuously, coupled with mortality and low fertility (see Chapter 14), supports the inference that high levels of yaws could have been sustained in New York.

Most of these infections may well be yaws. The presence of yaws in North America is noted in historic documentations (History Component Report, Chapter 10). Yaws was also the focus of a court case in New York in which an enslaved African was found to have the disease after her purchase (History Component Report, Chapter 10). Still, if the presence of yaws was used as a reason against purchase, then it is conceivable that this undesirable condition could lead to a slave owner avoiding afflicted individuals, thus possibly creating a reduction in the rates of disease in the population.

Whatever the nature of treponemal disease in the ABG, it is clear that the associated infection rates are neither as severe nor pervasive as those found in the Waterloo Plantation sample from Suriname (Khudabux 1991), where 56 percent were diagnosed as having treponemal infection, specifically venereal and congenital syphilis. This rate is much higher than the possible 16.1 percent found overall in the ABG sample, or the 21.0 percent observed in the adults. The vastly different sample sizes, 25 individuals at Waterloo Plantation versus the 249 individuals with observable tibiae discussed here, may influence the overall prevalence of infected persons. However, it must be noted that three individuals in the smaller Waterloo Plantation exhibited diagnostic stellate scars on the crania while the NYABG, a much larger series, had no definitive evidence of these lesions.[11]

Nutritional Inadequacy

The presence of porotic hyperostosis and diploic thickening were commonly found in the individuals of the NYABG. The *Standards* operationally defines porotic hyperostosis as cranial pitting; however, evidence of thickened diploe was also included in this study as an important characteristic of porotic hyperostosis. While often associated with anemia, particularly with iron deficiency anemia, current practice cautions against a direct correlation between anemia and porotic hyperostosis (Ortner 2003:55). Other disease processes that are implicated as possible causes of porotic hyperostosis include the nutritional disorders of scurvy and rickets, and infection (Ortner 2003:56, 383-418). At this time, radiographic data has not been investigated for the purpose of differential diagnosis. Furthermore, cranial cross sectional data, while potentially informative in this regard, was not collected at the NYABG.

An association of porotic hyperostosis observed in the ABG sample with metabolic dysfunction due to inadequate nutrition (e.g. iron deficiency anemia, rickets, and scurvy) is not unexpected, given the stresses associated with enslavement. Genetic anemia, while potentially present, should be limited in expression. The high rate of mortality associated with sickle cell anemia, particularly prior to modern medical intervention, would preclude an individual's representation in this population past adolescence. Also the low prevalence, 2-3 percent, of sickle cell anemia in Afro-

Caribbean and West African populations (Serjeant 1981) would suggest a similar low incidence in the NYABG. Infection as a possible source of porotic hyperostosis serves as the most likely confounding factor. Future study, incorporating radiographic data will aid in the differential diagnosis of cases of porotic hyperostosis. For the purposes of this study, porotic hyperostosis is used as a general indicator of nutritional inadequacy.

The occurrence of nutritional inadequacy, as represented by porotic hyperostosis observed in crania, is presented in Figures 10.18, 10.19, and 10.20 and Tables 10.8 and 10.9. Almost half, 130 (47.3 percent), of the observable crania exhibited at least one occurrence of porotic hyperostosis. Adults (93, or 50.5 percent) had a higher, though not statistically significant, incidence of this pathology than the subadults (35, or 39.8 percent). Adult males displayed a higher proportional rate of porotic hyperostosis (55, or 57.9 percent) than females (32, or 43.8 percent), though this was also not statistically significant.

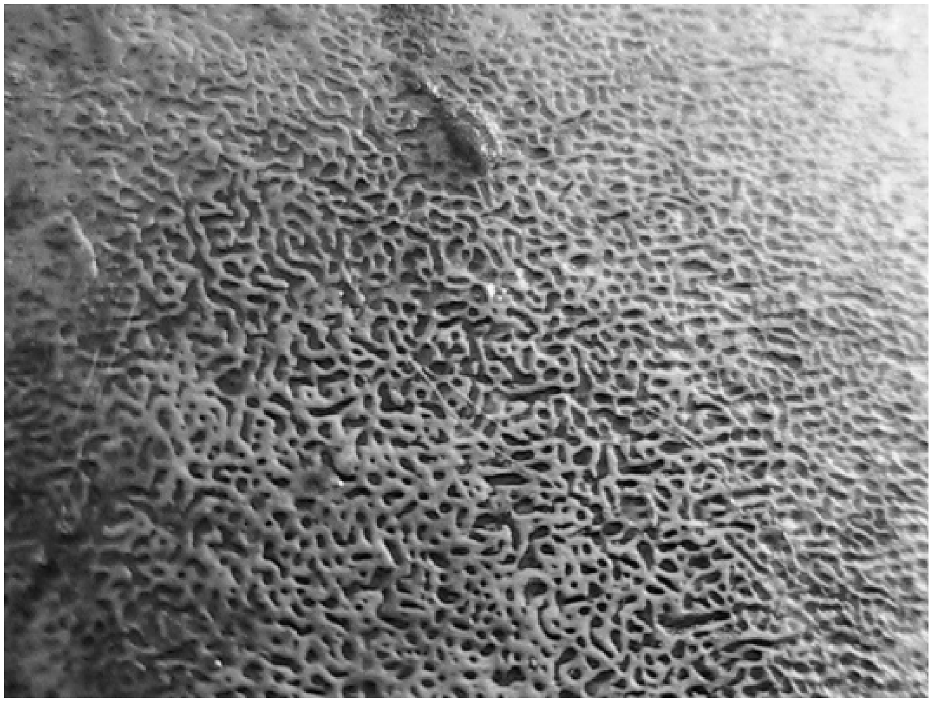

Figure 10.18: Porotic hyperostosis in right posterior parietal

(Burial 138, 3-5 years old)

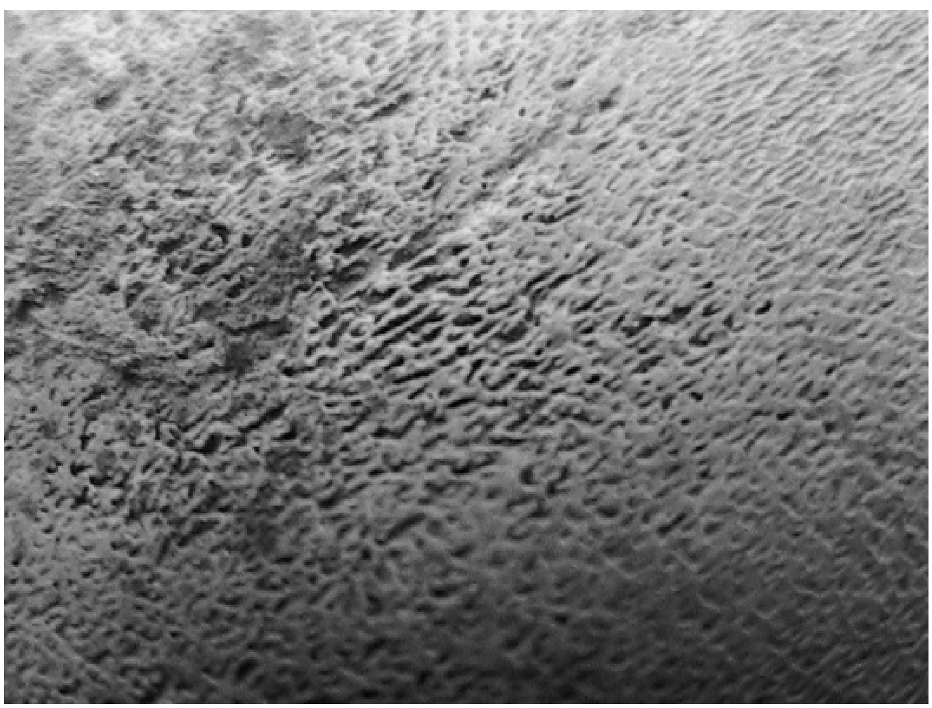

Figure 10.19: Porotic hyperostosis (Burial 64, 4.5-10.5 months old)

Figure 10.20: Thickened diploe of occipital adjacent to lambda, compared with a normal specimen at the same location (Burial 151, 35-45 year old male)

Table 10.8: Porotic Hyperostosis: All Cranial Locations

	N†	Total %	Active %‡	Healed % ‡	Both %‡
Subadult	88	**39.8**	16.7	83.3	0.0
Adult	184	**50.5**	1.5	89.4	9.1
Female	73	**43.8**	0.0	94.7	5.3
Male	95	**57.9**	2.3	86.4	11.4
Total	**275**	**47.3**	**4.8**	**88.1**	**7.1**

† "n" equals number of individuals with observable cranial elements.
‡ Status values represent the percentage of those in each group with evidence of porotic hyperostosis; cases of thickened diploe have been removed.

Table 10.9: Porotic Hyperostosis Statistical Testing: Intra-Population

	Porotic Hyperostosis Presence/Absence		Status of Lesions	
	x^2	p	x^2	p
Subadult/Adult	2.772	.096	.086†	.769
Male/Female	3.268	.071	.285†	.593

† Conditions for 2X3 contingency table not met, x^2 reflects the collapsing of "Active" and "Both" categories. Yeats Correction for Continuity utilized due to small "expected" cell values.

Healed lesions were observed in 74 (88.1 percent) individuals with porotic hyperostosis. Adults (59, or 89.4 percent) were marginally more likely than subadults (15, or 83.3 percent) to have only healed lesions, while subadults had a higher number of individual with only active lesions (3, or 16.7 percent) than adults (1, or 1.5 percent). However, the difference in status between subadults and adults was not statistically significant. Though also not statistically significant, adult males exhibited a higher proportion of individuals with both active and healed lesions (5, or 11.4 percent), and included the only adult instance of solely active porotic hyperostosis. Females, correspondingly, had a higher incidence of individuals with only healed porotic hyperostosis (18, or 94.7 percent).

As illustrated in Figures 10.21 and 10.22; Tables 10.10 and 10.11, rates were generally lower for the presence of porotic hyperostosis in the orbits than the rest of the cranium: an overall rate of 23.7 percent (54 individuals) for assessed orbits. Subadults (18, or 28.6 percent) had a higher rate of involvement in the orbits than the adults (36, 22.0 percent), contrary to what was observed for grouped cranial locations. However, it was found that this difference was not statistically significant. The pattern encountered with status of lesions of cribra orbitalia is similar to that found in with porotic hyperostosis. Interestingly, all individuals that exhibited solely active porotic hyperostosis were found to have the location of the lesion in the orbits (one adult male, three subadults).

When compared with FABC (Rankin-Hill 1997), Cedar Grove (Rose and Waterford 1985), and 38CH778 (Rathbun 1987), the ABG sample (47.3 percent) has a higher overall rate of porotic hyperostosis (Figure 10.23, Table 10.12). Interestingly, the ABG sample rates of porotic hyperostosis are very similar to Cedar Grove among the subadults, however more similar to FABC in adults. Focusing solely on pathology encountered in the orbits (Figure 10.24, Table 10.13), the ABG shows a similar population incidence as that found at Cedar Grove though less than that observed at

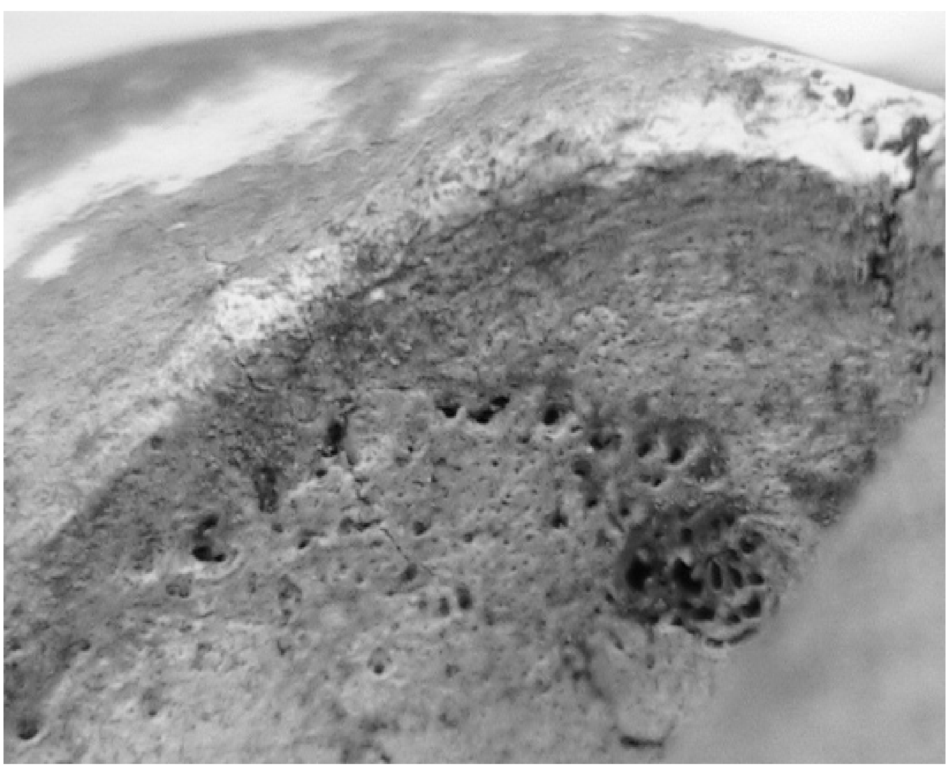

Figure 10.21: Cribra orbitalia of the left eye orbit (Burial 6, 25-30 year old male)

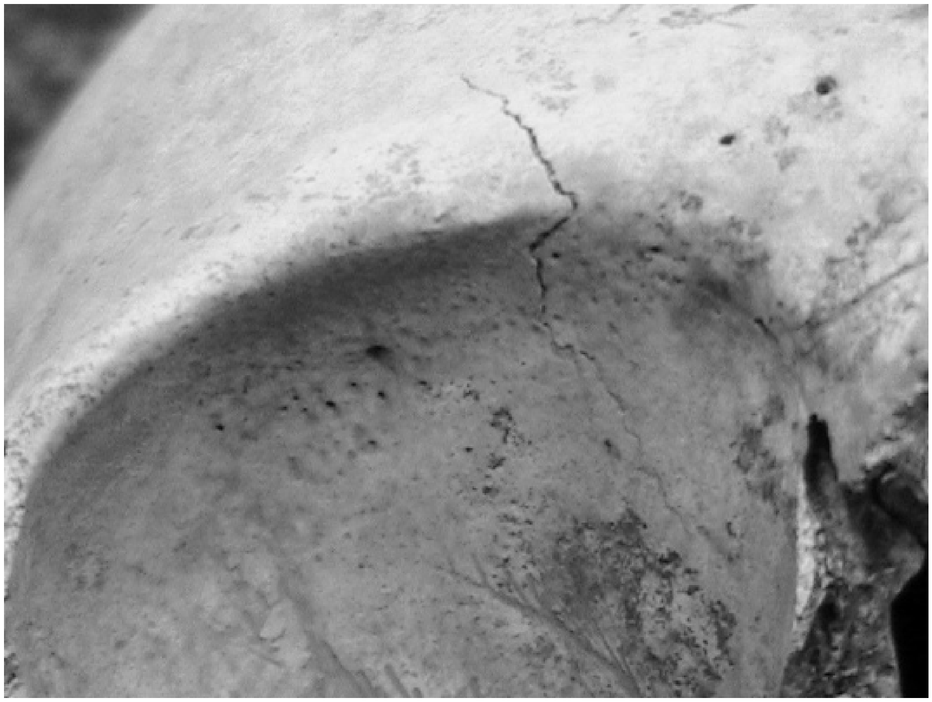

Figure 10.22: Cribra orbitalia of the right orbit (Burial 39, 5-7 years old)

Table 10.10: Porotic Hyperostosis: Cribra Orbitalia

	n[†]	Total %	Active %[‡]	Healed %[‡]	Both %[‡]
Subadult	63	**28.6**	21.4	78.6	0.0
Adult	164	**22.0**	2.9	91.4	5.7
Female	66	**18.2**	0.0	91.7	8.3
Male	86	**26.7**	4.5	90.9	4.5
Total	**228**	**23.7**	**8.2**	**87.8**	**4.1**

[†] "n" equals the number of individuals with observable eye orbits
[‡] Status values represent the percentage of those in each group with evidence of cribra orbitalia; cases of thickened diploe have been removed.

Table 10.11: Cribra Orbitalia Statistical Testing: Intra-Population

	Porotic Hyperostosis Presence/Absence		**Status of Lesions**	
	x^2	**p**	x^2	**p**
Subadult/Adult	1.100	.294	.575†‡	.448
Male/Female	1.545	.214		.432†*

† Conditions for 2X3 contingency table not met, x^2 reflects the collapsing of "Active" and "Both" categories.
‡ Yeats Correction for Continuity utilized due to small "expected" cell values.
* Fishers Exact Test.

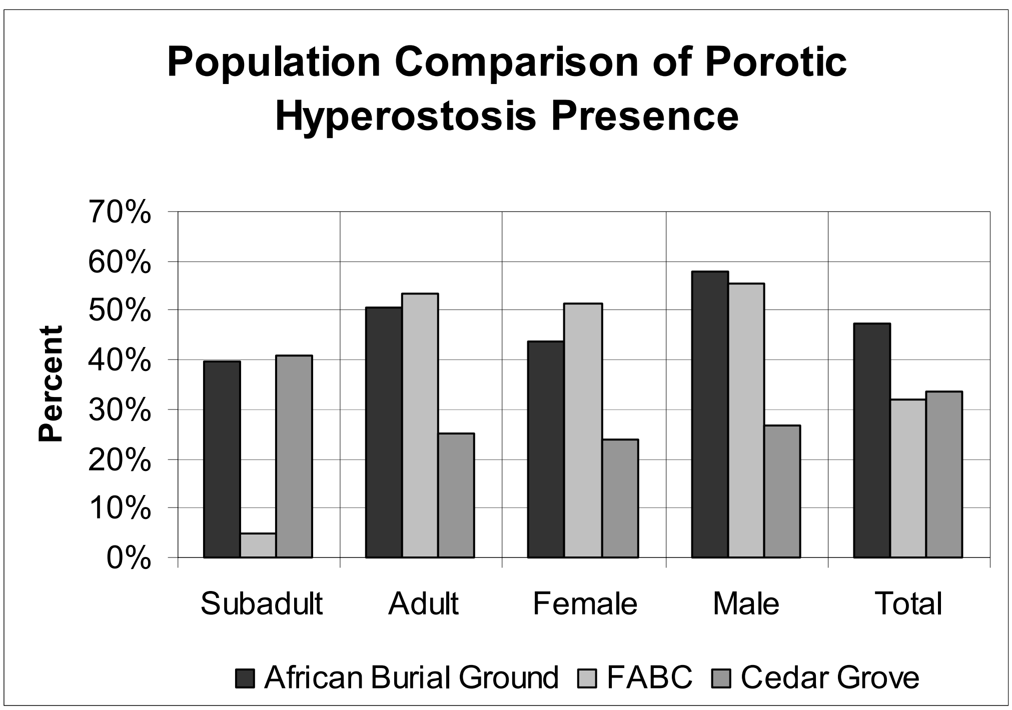

Figure 10.23: Population Comparison of Porotic Hyperostosis Presence

Table 10.12: Porotic Hyperostosis Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove	
	x^2	p	x^2	p	x^2	P
Subadult	24.689	<.001	22.605	<.001	.016	.900
Adult	8.957	.011	.166	.6384	7.900	.005
Female	4.270	.118	.567	.452	1.965†	.161
Male	5.128	.077	.058	.809	3.902†	.048
Total	10.890	.004	8.828	.003	4.594	.032

† Yeats Correction for Continuity utilized due to small "expected" cell values.

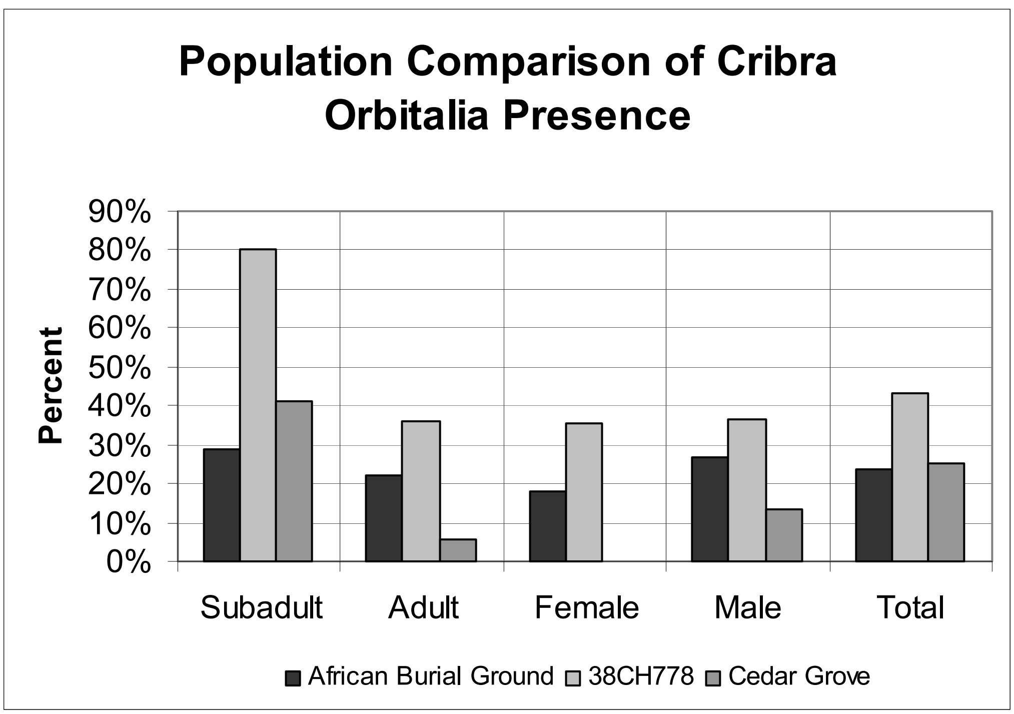

Figure 10.24: Population Comparison of Cribra Orbitalia Presence

Table 10.13: Cribra Orbitalia Statistical Testing: Inter-Population

	All Populations		African Burial Ground/Cedar Grove		African Burial Ground/38CH778	
	x^2	p	x^2	P	x^2	p
Subadult	‡	‡	1.766	.184	3.495†	.062
Adult	8.688	.013	4.146†	.042	1.649†	.199
Female	7.902	.019	3.032†	.082	1.203†	.273
Male	1.894	.388	.618†	.432	.098†	.754
Total	5.385	.068	.056	.813	4.351†	.037

† Yeats Correction for Continuity utilized due to small "expected" cell values.
‡ Conditions not met for 2X3 contingency table.

38CH778. The 38CH778 population displays higher cribra orbitalia rates in all categories however, only the total population comparison is statistically significant. The similarity between the ABG and Cedar Grove diminishes when the samples are partitioned by age: higher comparative rates found among subadults at Cedar Grove, conversely higher rates in adults at the ABG (the latter is statistically significant).[12]

Porotic hyperostosis (all locations) in subadults is found most frequently in the 1.0 – 4.9 and 5.0 – 9.9 age groups (Figure 10.25). This pattern is also apparent when considering the prevalence of the disorder within age grades (Figure 10.26). The disproportionately lower rates in the first year seem to suggest, similar to the periostitis rates, that the individuals in the older age grades may have survived earlier insults and that the younger individuals are dying prior to skeletal involvement of the pathology. Interestingly, all subadult cases of active porotic hyperostosis (cribra orbitalia,) occurred in the first year. Older subadult age groups displayed only healed lesions.

When the subadult distribution of porotic hyperostosis is compared with other populations, rates observed in the ABG samples are consistently higher than those from

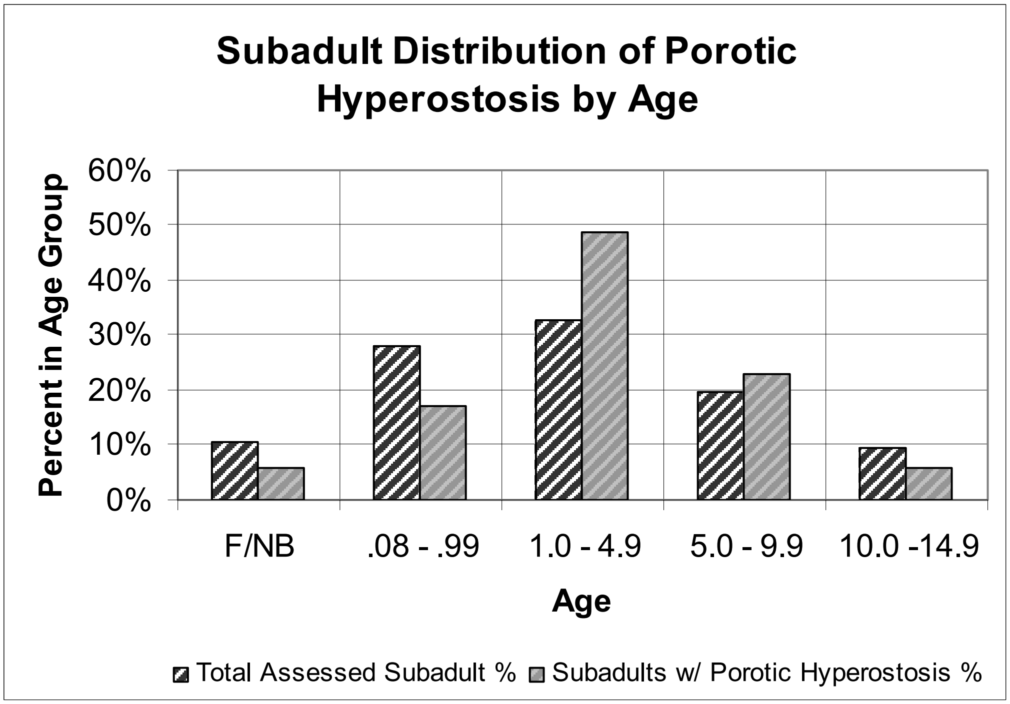

Figure 10.25: Subadult Distribution of Porotic Hyperostosis by Age

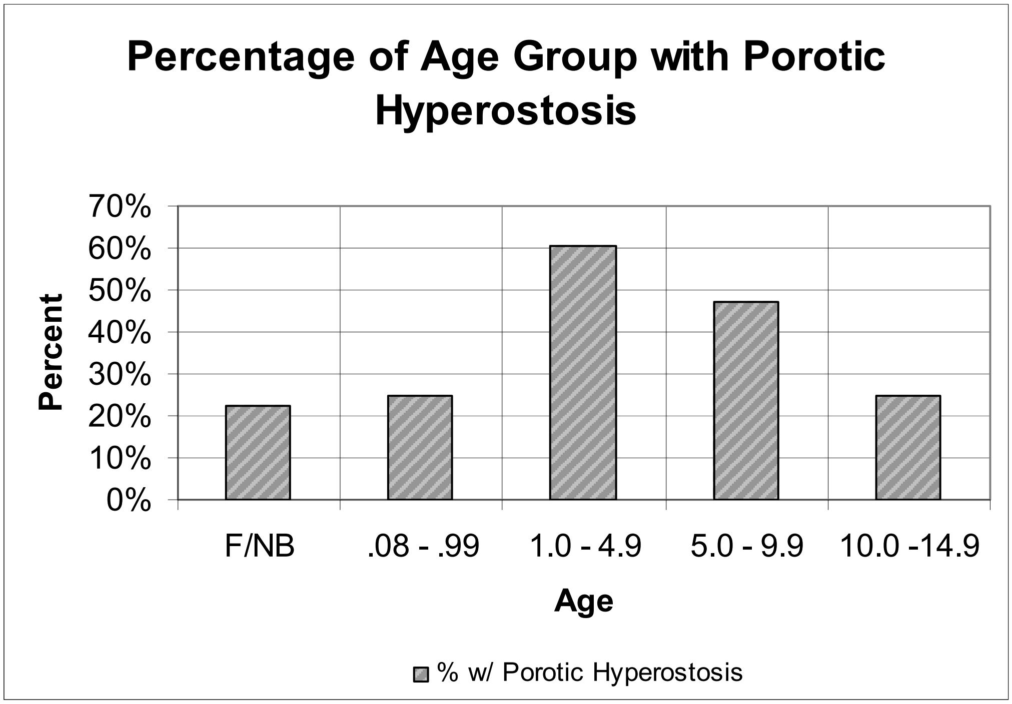

Figure 10.26: Percentage of Age Group with Porotic Hyperostosis

FABC (Figure 10.27). Rates of porotic hyperostosis are lower in the first two years at the NYABG than those found at Cedar Grove. However, the ABG subadults do display a higher rate than Cedar Grove subadults in the 6 – 15 year range. The apparent disparity seen in the 25 months – 5 year age range may be attributable to the sample size in the FABC and Cedar Grove populations.

Among adults, porotic hyperostosis is higher overall, except in the 20.0 – 24.9 and 50.0 – 54.9 year age groups (Figure 10.28). Disparities between males and females are not as great in the younger adult age groups, from 15.0 to 29.9 years. Both male and females experience peaks in porotic hyperostosis frequencies in the 25.0 – 29.9 and 35.0 – 39.9 year age groups. In comparisons with other populations, no clear pattern emerges (Figures 10.29 and 10.30). Female rates for porotic hyperostosis in the ABG are higher in all adult age categories except in the fifth decade where both FABC and Cedar Grove have higher rates. Male rates of porotic hyperostosis at the ABG are more consistent throughout the adult age ranges than those found in the Cedar Grove and FABC populations, though this difference is possibly a factor of sample sizes within these age groups in the latter two populations.

Another possible example of metabolic disruption due to nutritional inadequacy is long bone bowing. Medial/lateral bowing of the lower limb was observed in a number of individuals, possibly indicative of metabolic disruption due to vitamin-D deficiency (rickets) (Table 10.14 and 10.15). Only individuals who expressed bowing bilaterally were included in this analysis thus limiting the confounding effect of post- mortem distortion. Approximately 11.9 percent of individuals with observable lower limb bones exhibited medial/lateral bowing. Adults (14.4 percent) had a higher rate than subadults (6.5 percent), though this difference was not statistically significant.

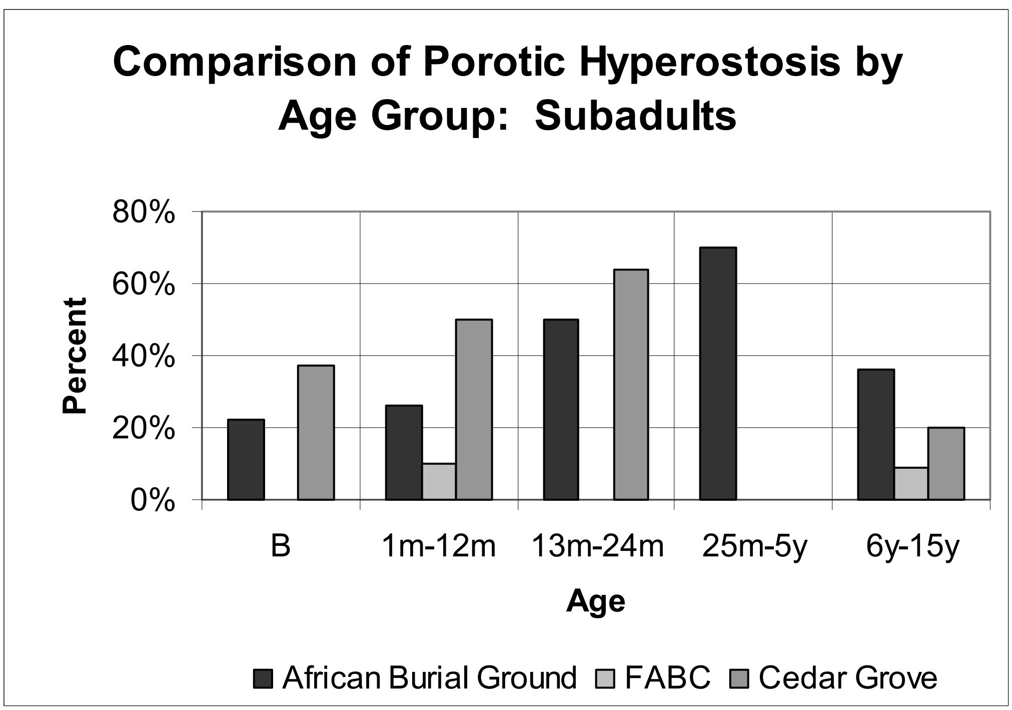

Figure 10.27: Comparison of Porotic Hyperostosis by Age Group: Subadults

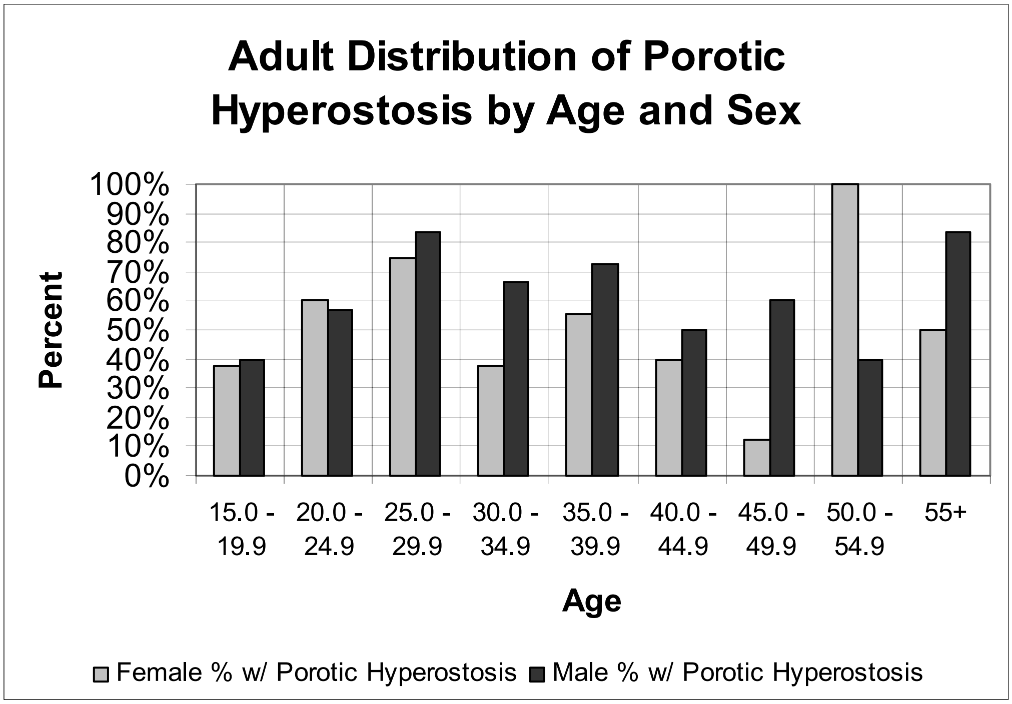

Figure 10.28 Adult Distribution of Porotic Hyperostosis by Age and Sex

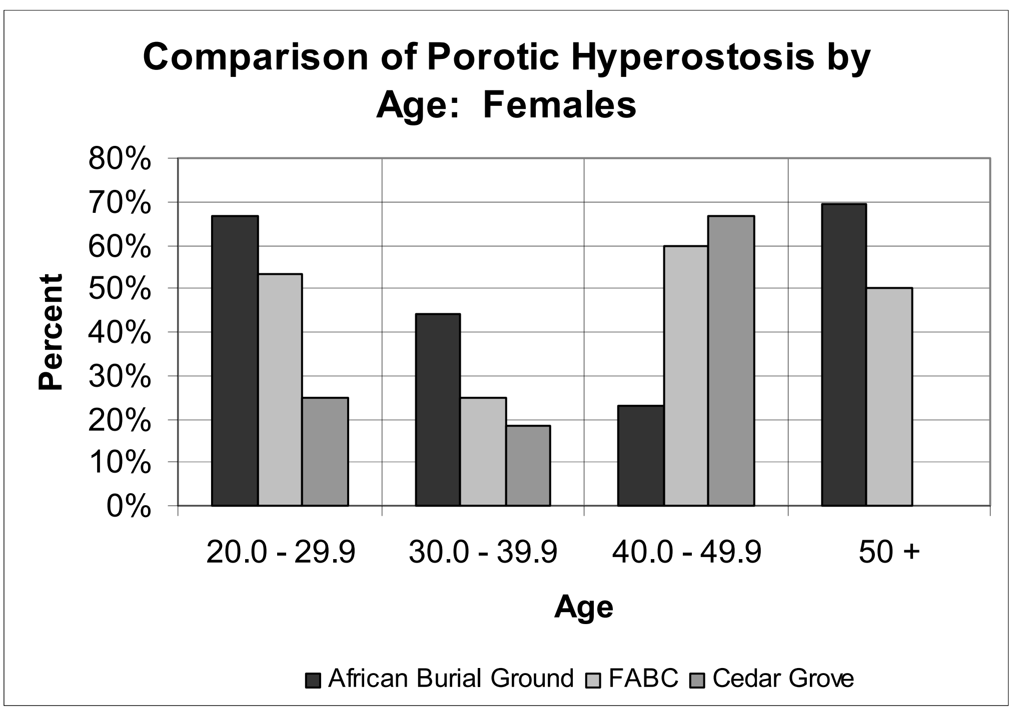

Figure 10.29: Comparison of Porotic Hyperostosis by Age: Females

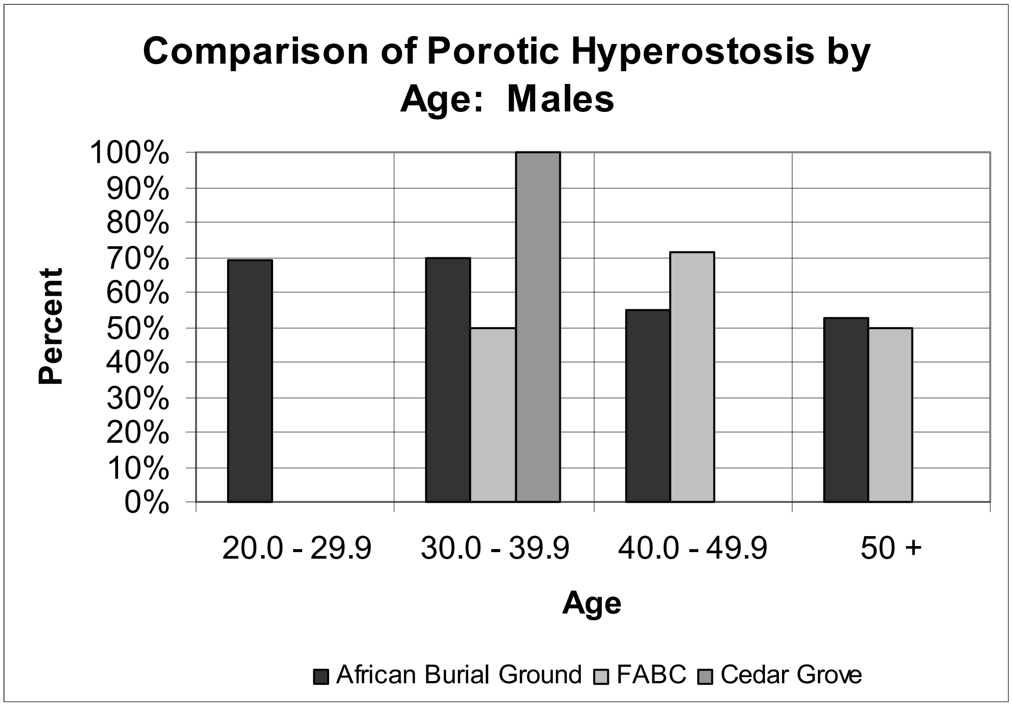

Figure 10.30: Comparison of Porotic Hyperostosis by Age: Males

Table 10.14: Medial/Lateral Bowing of the Lower Long Bones

	n†	Total N‡	Total %	Clearly Present n*	Clearly Present %
Subadult	77	**5**	6.5	2	2.6
Adult	202	**29**	14.4	5	2.5
Female	77	**13**	16.9	1	1.3
Male	102	**15**	14.7	4	3.9
Total	**285**	**34**	**11.9**	**7**	**2.5**

† "n" equals the number of individuals with observable long bones of the lower extremities
‡ "n" equals the number of individuals with bilateral medial/lateral bowing of the elements.
* "n" equals the number of individuals with "clearly present" bilateral medial/lateral bowing of the elements.

Table 10.15: Medial/Lateral Bowing Statistical Testing: Intra-Population

	Medial/Lateral Bowing Presence/Absence		Clearly Present	
	x^2	p	x^2	p
Subadult/Adult	2.528†	.112	.137†	.711
Male/Female	.158	.691	.356†	.551

† Yeats Correction for Continuity utilized due to small "expected" cell values.

Among adults, females (16.9 percent) display a slightly higher frequency, though not statistically significant, of medial/lateral bowing than males (14.7 percent). When cases of medial/lateral bowing that were determined "clearly present" (as opposed to "barely discernable" or no severity determined) were considered, fairly consistent rates where observed throughout the sample. While not statistically significant, males (3.9 percent) did exhibit a higher rate than females (1.3 percent). In comparison with FABC, which contained only one diagnosed case of rickets, the data may suggest a higher potential rate of this disorder at the ABG. The rate of rickets in the ABG sample, on the other hand, was not as great as that found among the Catoctin Furnace sample of enslaved industry workers from Maryland, where 50 percent of females and 75 percent of males exhibited tibial bowing (Kelly and Angel 1987:206). While this disparity in rates may be in part due to differential scoring of tibial bowing, the greater prevalence at Catoctin Furnace seems to indicate that vitamin-D deficiency was more common in that sample than at the ABG.

The presence of scurvy (vitamin-C deficiency), another nutritional disorder that could potentially be present among the individuals of the ABG, was not investigated at this time. Research related to the skeletal expression of scurvy by Ortner et al. (1999)

and others will provide a useful framework for future investigation of this nutritional disorder in the ABG.

Interaction of Infectious Disease and Nutritional Inadequacy

The interaction of infectious disease and nutrition is of particular concern, especially in enslaved people such as, those interred at the ABG. Interestingly, historical research has found that the synergistic relationship between these two issues was also a concern in the past (History Component Report, Chapter). To investigate this synergism, frequencies of porotic hyperostosis and periostitis were considered together (Table 10.16 and 10.17). As can be seen in Table 10.16, over one third (34.2 percent) of the individuals from the ABG exhibited skeletal indicators of both porotic hyperostosis and periostitis.

Adults (40.8 percent) were almost twice as likely as subadults (20.5 percent) to have both pathologies. Of the adults, males (48.4 percent) had an 11 percent higher, though statistically not significant, proportion of individuals with periostitis and porotic hyperostosis than the females (37.0 percent). Upon examining the co-occurrence of individuals with porotic hyperostosis who also had periostitis, we found that almost three-quarters (72.3 percent) of those in the population with porotic hyperostosis also had infectious disease. Once again subadults (51.4 percent) exhibit lower rates than adults (80.6 percent); however, males and females have very similar incidences of periostitis among those with porotic hyperostosis.

Upon comparing rates of individuals that have both porotic hyperostosis and periostitis, we found that the ABG exhibits higher overall percentages than the values for

Cedar Grove (Rose and Santeford 1985) and FABC (Rankin-Hill 1997), though this difference is not statistically significant (Figure 10.31 and Table 10.18). Subadults at the ABG present-intermediate rates: is lower than Cedar Grove, yet higher than FABC. Among adults, the ABG exceeds the co-occurrence incidence of porotic hyperostosis and periostitis in both Cedar Grove and FABC. This pattern maintains when sex-specific

Table 10.16: Co-occurrence of Porotic Hyperostosis with Periostitis

	N†	Porotic Hyperostosis		Porotic Hyperostosis with Periostitis		
		n‡	%	N*	% of Group	% of PH
Subadult	88	35	39.8	18	20.5	51.4
Adult	184	93	50.4	75	40.8	80.6
Female	73	32	43.8	27	37.0	84.4
Male	95	55	57.9	46	48.4	83.6
Total Population	**275**	**130**	**47.3**	**94**	**34.2**	**72.3**

† "n" reflects the number of individuals with a pathologically assessed cranium, removing the potential of including individuals in the sample that could not be investigated for porotic hyperostosis
‡ "n" equals the number of individuals with observable porotic hyperostosis
* "n" equals the number of individuals with observable porotic hyperostosis that also have observable periostitis

Table 10.17: Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing: Intra-Population

	Within Population Presence/Absence		Within Porotic Hyperostosis Presence/Absence	
	χ^2	P	χ^2	p
Subadult/Adult	10.909	.001	9.505†	.002
Male/Female	2.197	.138	.045†	.832

† Yeats Correction for Continuity utilized due to small "expected" cell values.

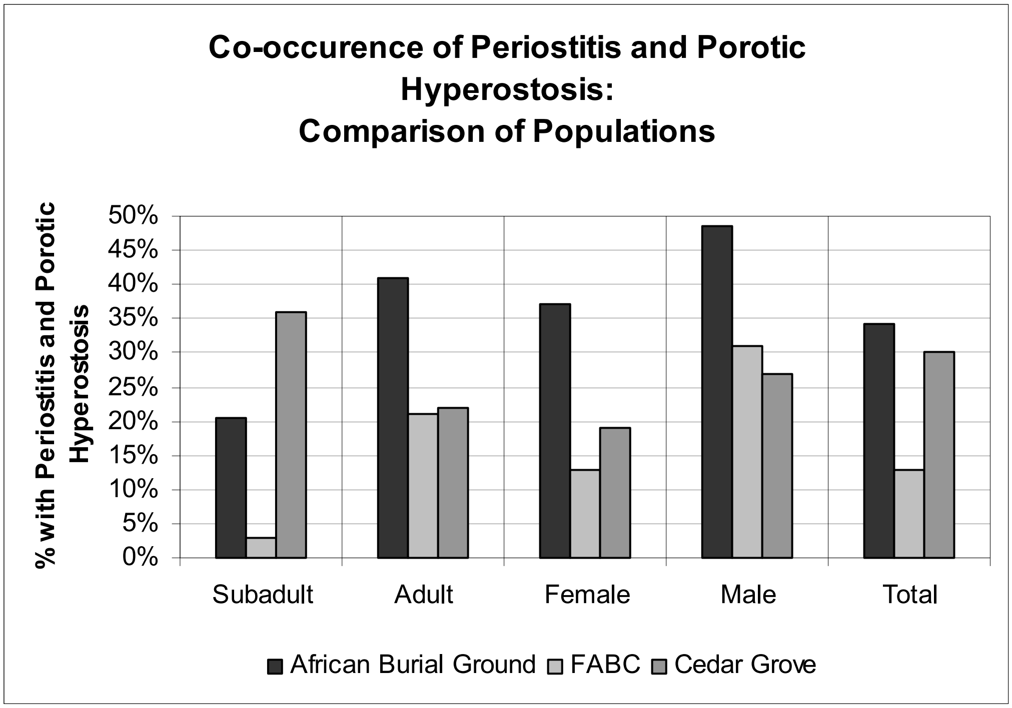

Figure 10.31: Co-occurrence of Periostitis and Porotic Hyperostosis: Comparison of Populations

Table 10.18: Co-occurrence of Porotic Hyperostosis with Periostitis Statistical Testing: Inter-Population

	All Populations		African Burial Ground/FABC		African Burial Ground/Cedar Grove	
	x^2	p	x^2	p	x^2	p
Subadult	18.489	<.001	7.543†	.006	3.882	.049
Adult	11.383	.003	8.824	.003	4.405	.036
Female	8.332	.012	7.274	.007	1.632†	.201
Male	4.996	.082	3.390	.066	1.673†	.196
Total	19.869	<.001	19.823	<.001	.488	.485

† Yeats Correction for Continuity utilized due to small "expected" cell values.

rates are considered, though the only statistical difference that exists in this case is between females in the NYABG and FABC populations.

These results suggest that while Cedar Grove may indeed have experienced higher overall frequencies of periostitis than that found at the ABG, the interactive patterning for porotic hyperostosis and periostitis is similar at population level. However, this interaction appears to have affected age groups differently, greater among adults in the ABG, and greater in subadults at Cedar Grove. The similarity in adult rates for porotic hyperostosis in the ABG and FABC populations is not replicated in the co-occurrence rates of porotic hyperostosis and infectious disease. This would suggest a greater interaction of the two disorders in the ABG sample. Further investigation of co-occurrence rates of porotic hyperostosis and periostitis among these populations should be a productive venue for future research.

Conclusion

This chapter has focused on the indicators of infectious disease and nutritional inadequacy in the enslaved African population of colonial New York City as represented in the ABG. The rates of generalized infectious processes observed in this investigation were high regardless of age or sex. Adult infectious disease was found to be more comparable to Southern plantation (Rathbun 1987) and post-reconstruction rates (Rose and Santeford 1985), when compared to the similar urban environment of free "people of colour" in early nineteenth century Philadelphia (Rankin-Hill 1997). Rates of porotic hyperostosis were less consistent: NYABG subadults were found to be closer to the post-reconstruction Cedar Grove subadults, while the adults are more similar to adults in

Philadelphia's First African Baptist Church. However, the rate of cribra orbitalia was not as extreme as that found in the nineteenth century 38CH778 Southern plantation population. The interplay of infection and porotic hyperostosis was evident in the high numbers of persons with indicators of both pathologies.

The presence of treponemal infection is well documented in this study. While diagnosis of a specific treponemal form was not possible, at least some individuals were apparently infected prior to their arrival and that venereal syphilis was not a common treponemal infection in the particular case of colonial New York. This is significant because of the high prevalence of venereal syphilis associated with European colonialism throughout the Americas. Thus the plausibility of higher rates of the tropical disease, yaws, and lower rates of venereal syphilis may substantiate other evidence of the continuous importation and high mortality of African captives in eighteenth-century New York. The duration of exposure to venereal syphilis among these individuals may not have been adequate for the manifestation and expression of severe symptoms. Groups coming here from a region of endemic yaws may have been provided vaccine-like immunity to other treponemal strains. Furthermore, the rates of infection were not nearly so high nor as severe as those of widespread infection of venereal syphilis found in Suriname (Khudabux 1991).

As discussed in Chapter 13, the only infectious disease whose rates were documented for New York Africans is smallpox, in connection with one of the several epidemics that ravaged New York, Boston, and Philadelphia in the eighteenth century. The 'vindicationist' work of Cobb (1981) has called attention to the Akan, West African use of smallpox inoculation and their introduction of this medical practice to the English colonies, including nearby Boston. Smallpox infection may have contributed to the periostitis observed in skeletal remains, but specific skeletal indicators of this disease were not studied here. A slightly lower mortality for Africans than for Europeans was recorded for the epidemic. That result would seem counterintuitive, assuming that the enslaved population had lived under worse conditions for the spread of epidemic diseases than did free persons. Inoculation should be considered as a factor in the relationship between disease prevalence and death rates (see Chapter 13).

The information presented here suggests that infectious disease, in conjunction with inadequate nutrition, was another source of chronic stress for the enslaved population of the NYABG. ABG studies of disrupted growth and development and of early mortality are consistent with these findings.

Notes

[1] We refer to *observable* remains as the precise technical category of bones well enough preserved to give clear evidence of the presence or absence of pathology. Observable bones in the 52 individuals showed no pathology. Yet, these were skeletons with few observable bones, and many bones were in such poor conditions as to provide no information, possibly hiding additional pathologies. We treat them nonetheless as the sample of non-pathological or reasonably healthy persons.

[2] As entirely *unobservable* these individuals cannot be shown to be healthy or pathological and are removed from our statistical treatment altogether.

[3] For purposes of this study, individuals whose sex determination was uncertain, i.e. identified as "possible male" or "possible female," were included in the "male" and "female" categories. One individual, Burial 358, was identified as a female; however, an age was undetermined. This individual was included as an adult female for purposes of generating a population size, but was not included in any assessments of pathologies discussed in this chapter.

With respect to age, five-year demographic age groups (see Table 10.1) were utilized when discussing population prevalence of a particular anomaly. However, when sample sizes warranted, e.g., subadults, larger groupings were utilized. Different groupings were also utilized in inter-population comparisons due to inconsistent age grouping strategies. The only difficulty encountered was individuals with a composite age of 15. In this chapter, individuals with a composite age of 15 are included as adults, and as such are not included in the subadult comparisons. It was found that while this exclusion had an effect on the frequencies generated, it did not change overall conclusions made in this chapter.

[4] Ortner notes that periostosis, rather periostitis, is the "more appropriate term" for such conditions; however, he continues to utilize the more common periostitis in his most recent volume due to less common usage of periostosis in the medical literature (Ortner 2003:51-2).

[5] However, it could be argued that many cases of trauma related periostitis may be the result of secondary infection.

[6] A "p" value of .05 was utilized in all statistical tests to determine significance.

[7] While the attempt was made to ensure that similar skeletal lesions were being compared in all pathological conditions discussed in this chapter, possible inter-observer variation between populations in the identification of these conditions can not be completely discounted. The possible effect that this could have on the analyses discussed in this chapter are unknown at this time.

[8] In the St. Peter's Cemetery population from New Orleans six adults were found to have post crania periostitis, generating a population prevalence of between 13.0 percent and 4.5 percent depending on the element considered (Owsley et al.1987). Unfortunately, the small sample size and mixed ethnic background of this population limits any comparative statements that could be made.

[9] These two similar conditions, saber shin and boomerang leg, will be referred to singularly as saber shin for the remainder of the chapter.

[10] While the potential for congenital transmission of yaws has recently been discussed (Ortner 2003:277), it is unclear at this time how this form of congenital treponemal infection can be differentiated from non-congenital yaws or other treponemal infections.

[11] Jacobi et al. (1992) report three cases of possible congenital syphilis (based on dental criteria) in the Newton Plantation population. Based on sample size, these three cases equated to 3.8 percent of the population, from which the authors estimated an actual congenital syphilis rate of approximately 10 percent for the population (1992:153-154). See the dental pathology chapter (Chapter 11) for a thorough discussion of possible dental indicators of treponemal infection.

[12] Two cases of cribra orbitalia, both adult females, were present in the St. Peter's Cemetery population equating to a population rate of 12.5 percent, or a sex specific 33.3 percent rate among females (Owsley et al. 1987:190). Once again, however, these conclusions are limited by small sample size and mixed ethnic composition in the population.